SPECIAL TIME EDITION

The Science of MEMORY

The Story of Our Lives

Build a Sharper Mind • Erase Bad Memories
A New Understanding

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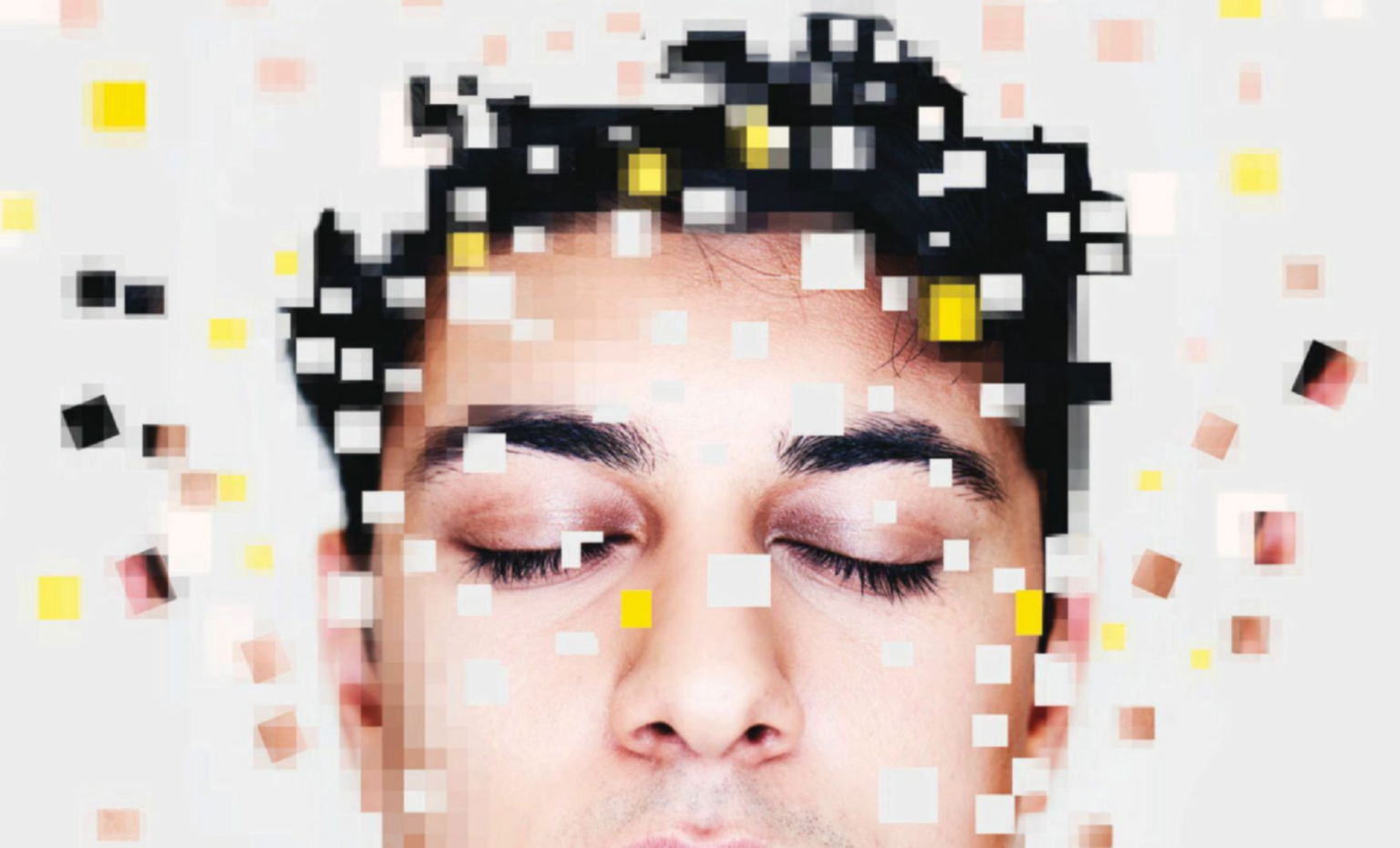
THE STORY OF OUR LIVES



Memories are often compared to snapshots, but memory itself is complicated, and researchers don't fully know how it works.

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Parts of this edition appeared previously in TIME and *Health*.

Early humans had to remember where predators hid. Illustration from L'Homme Primitif *by Louis Figuier.*

Why We Remember

From an evolutionary point of view, it comes down to survival of the fittest. He who endures remembers where the food is and where the predators lurk

BY EILEEN DASPIN

For an experiment on navigational skills and natural selection, the setting—a Santa Barbara, Calif., farmers market on a Saturday morning—could not have been more Darwinian. So was the question at hand: How would spatial memory and adaptive behavior play out for a modern hunter-gatherer?

To find out, a group of psychology professors posted themselves at the market's entrance and enlisted shoppers as foragers. Eighty-six subjects were led along intentionally circuitous routes to preselected food stalls. There, they tasted the farmers' goods, were guided to the center of the market and finally were given a special device to indicate the locations of the foods they had sampled. True to Paleolithic form, the shoppers easily identified the locations that provided goods with the most energy—olive oil, avocados and nuts—but struggled to place booths stocking calorie-light leafy greens.

"I was surprised at how cleanly the results came out," says psychology professor Joshua New, one of the designers of the study, who now teaches at Barnard College at Columbia University. "People hadn't thought about encoding landmarks like that. But if you eat at a subpar restaurant, you're not going to commit memory to learning how to get back there."

From an evolutionary point of view, the reason we remember, like pretty much all human activity, comes down to survival of the fittest. He who is going to make it out alive remembers where the food is. And what the bad guys look like. And the best place to hide from predators. What scientists call adaptive memory—which is always functioning to figure out new solutions to problems—is key to nearly everything we do. We have to remember to physically navigate the world, to reproduce, to interact with others, to recognize kin, to know the truth of a situation. Memory is what allows us to learn, to acquire, to store and to retrieve information.

As machines, our memories are amazing, able to store long-term some 2.5 petabytes of data, by one professor's calculation. That's the equivalent of 300 million hours of television programming. The catch is that memories are as faulty as they are essential. No two people remember the same event the same way, a fact famously illustrated in the Japanese crime drama *Rashomon*, in which four people each remember killing the same samurai—including the samurai himself, who returns from the dead to testify that he had committed hara-kiri.

Memory is so crucial, we even forget to remember, with the brain pushing out less important memories to make room for the more important ones. This is a phenomenon that Friedrich Nietzsche called "active forgetfulness," by his lights, an important component of happiness. The German philosopher's argument wasn't that you should be pleased you forgot where you parked your car, but rather that not remembering paves the way for peace of mind. "To shut the doors and windows of consciousness for a while . . ." Nietzsche wrote in *On the Genealogy of Morals/Ecce Homo*, allows for "a little tabula rasa of consciousness to make room for something new . . . like a doorkeeper or guardian of mental order, rest and etiquette."

Our memories are amazing, able to store long-term some 2.5 petabytes of data—about 300 million hours of television programming.

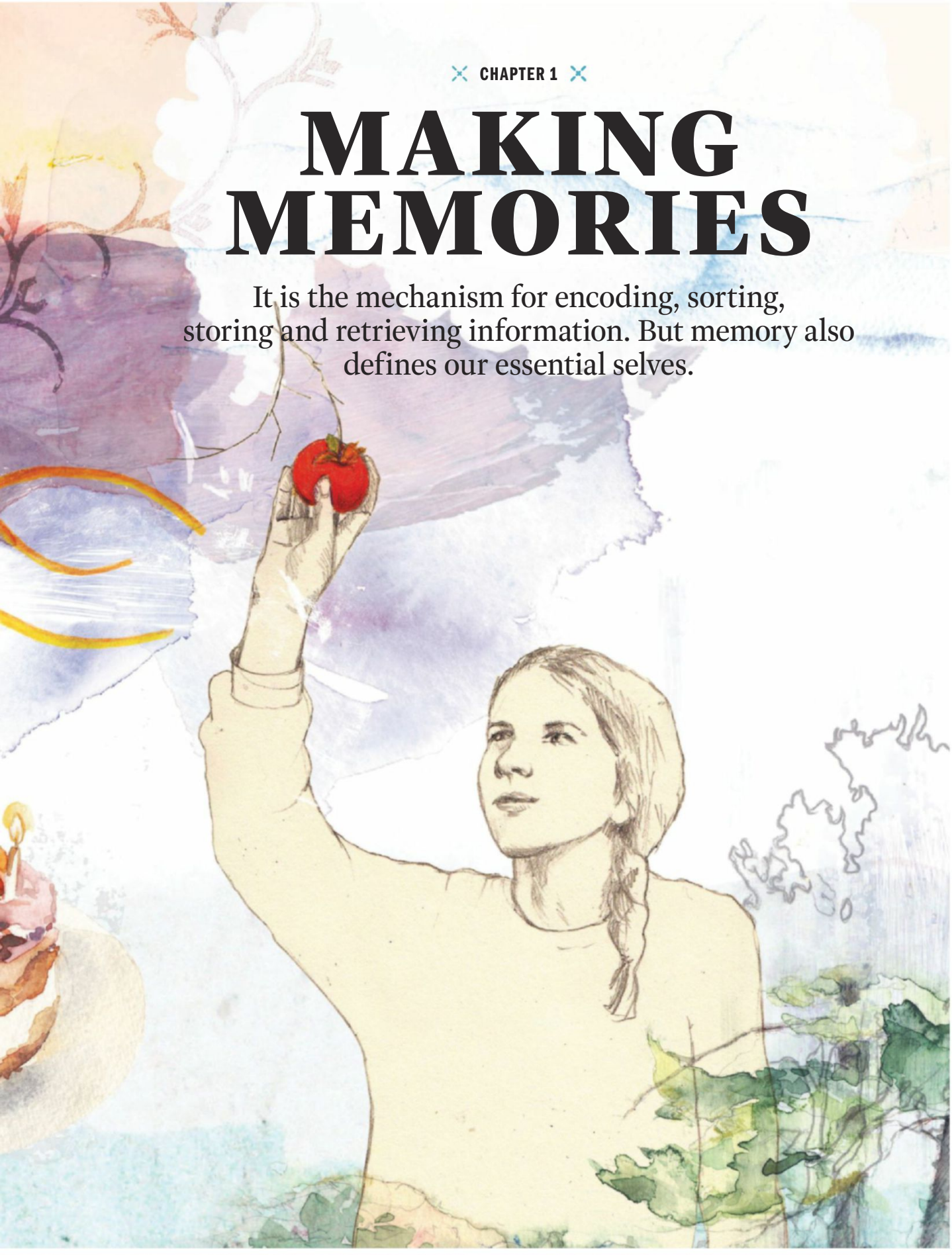
Research suggests that memory literally starts in utero. When Dutch professors put a honking, vibrating device on the abdomens of women in their 30th to 38th weeks of pregnancy, they found that the fetuses quickly recalled the noise, so that when the device was sounded 10 minutes later, they didn't squirm and their heartbeats remained stable. The 34-week-olds even remembered the noise four weeks later. "It's like getting used to a New York train station," lead author J.G. Nijhuis told *Scientific American*. "It is a learning capability to distinguish safe from unsafe stimuli. It is a primitive form of memory."

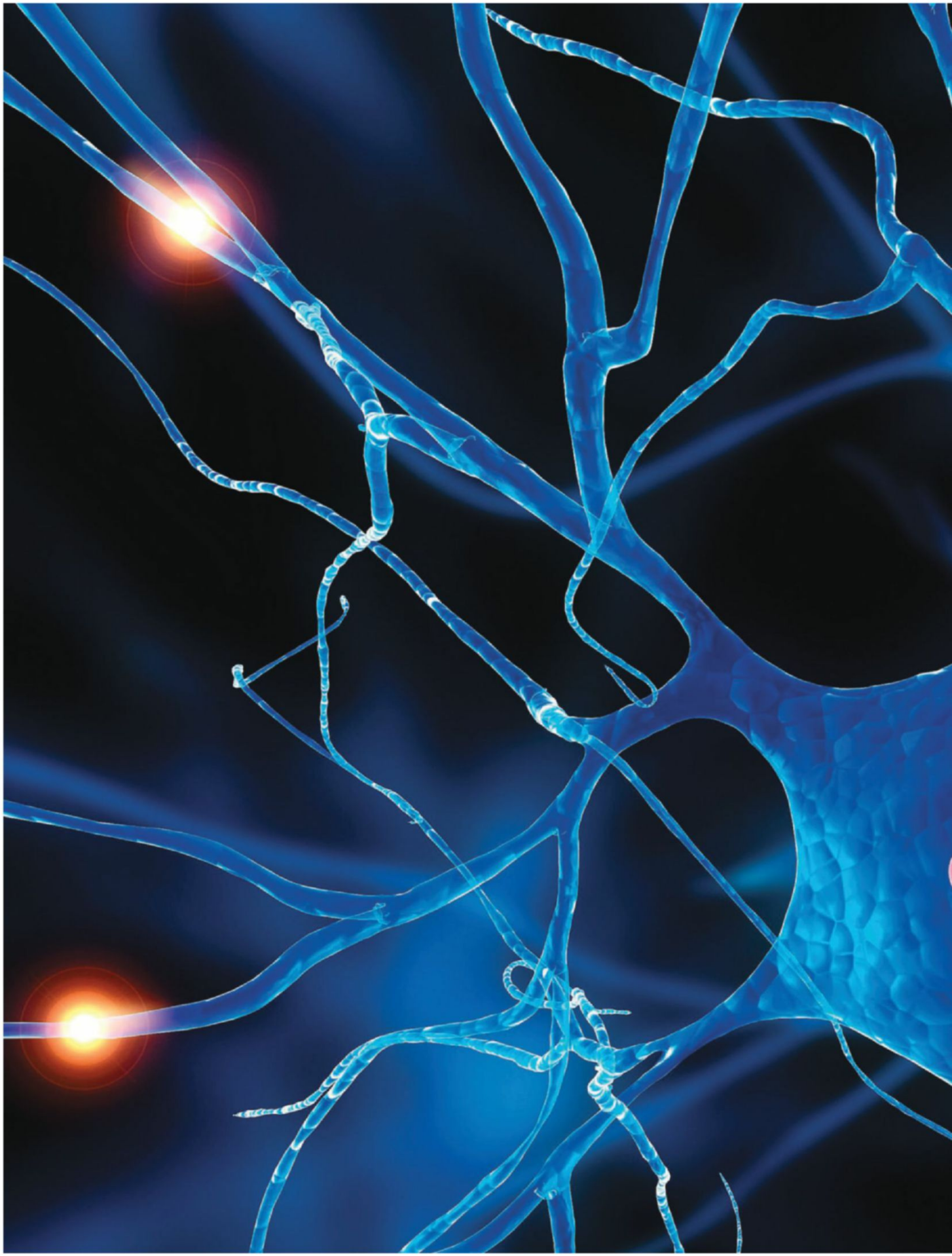
Then it gets a little more complicated. Infants and toddlers remember, but by about age 7, the first three years of memories are almost entirely erased from the conscious memory and overlaid with new ones. From there, our memories shift and evolve, colored constantly by our experiences. Why do we remember? As Oscar Wilde once suggested, to fill in "the diary we all carry about with us." □

CHAPTER 1

MAKING MEMORIES

It is the mechanism for encoding, sorting, storing and retrieving information. But memory also defines our essential selves.





The Biology of Memory

Our capacity to remember does not exist in a discrete niche of the brain but rather involves several areas working together to make sense of our experiences

BY RICHARD JEROME

IT WAS AN UNLIKELY VENUE FOR AMERICANS to receive a lesson in neuroscience. During the 2018 Senate hearings into sexual-assault allegations against Supreme Court nominee Brett Kavanaugh, accuser Christine Blasey Ford delved into the workings of the human brain to explain why she could vividly recall the alleged attack, decades earlier, but not specifics, like the date of the party.

At work were the levels of norepinephrine and epinephrine in the brain, said Ford, a professor of psychology. When activated, those hormones, key to the fight-or-flight reflex, encode memories into the hippocampus, a memory center in the brain. Among other things, norepinephrine and epinephrine serve to lock in "the trauma-related experience," explained Ford, "whereas other details kind of drift." Cable-news commentators rushed to define the hippocampus for their audiences, but reconciling the gulf between Ford's recollections and Kavanaugh's proved, as we know, impossible.

That could have been predicted. The science of memory has intrigued and baffled researchers for

Researchers at the University of Oxford study postmortem brain samples.

decades. In the broadest sense, memory is the mechanism for receiving information and then encoding, sorting, storing and retrieving it. The act of remembering is absolutely essential to our survival. We could not carry out the basic functions of living unassisted without our powers of recall. Learning would be impossible; nothing in the world would have context. We would have no sense of self—indeed, we wouldn't know what we'd done five seconds ago. Only within the past 70 years or so have researchers begun to understand the neurological and physiological operations that make this enigmatic but indispensable faculty possible. What's clear is that the human memory doesn't reside in one corner of the brain that scarfs up stimuli and records them for later retrieval. Rather, it's a complex system, involving several areas of the brain, working to make sense of life's experiences. And a great deal about it remains to be understood.

Neurobiologists have identified two main classes of long-term memory at work in the brain. Explicit (or declarative) memory, which is processed in the hippocampus and medial temporal lobe, is conscious recollection of names, dates, events, people, places and objects; it includes two subcategories: episodic memory, which logs one's personal experiences—say, the coffee date you had last week or your first kiss; and semantic memory, which stores factual information. The second major class of recall is implicit memory, which encompasses unconscious, procedural or motor tasks: walking, tying your shoe—things we do routinely, without conscious thought. Implicit memory calls on other brain systems, such as the cerebellum (which regulates muscle activity) and the striatum (a cluster of neurons that regulate voluntary movement).

When a memory forms, the first, crucial step is encoding. For example, when meeting a person for the first time, our various senses take in their looks, the sound of their voice, the smell of their breath or body, the feel of their handshake. All that sensory input gets stored and analyzed in the hippocampus. The information gets evaluated—graded, in a way, to determine whether it's worth retaining as part of your long-term memory. In a process known as consolida-

tion—a window of a few hours that is enhanced by sleep—memories deemed worthy of retention are stabilized, and then associated neurons are transferred to the neocortex, the wrinkly sheet of neural tissue that forms the outside surface of the brain. Another key cog in the brain's memory-retention complex is the amygdala, an almond-shaped structure in the temporal lobe that imbues recollections with emotional significance, associating them with shame, joy, love, grief or fear. Emotionally charged events are generally much harder to forget—they're sometimes referred to as "flashbulb memories" because they stand out so vividly.

We know the brain's major memory centers, but what goes on there, exactly? How are memories encoded and stored? Through a complicated interplay of electricity and chemicals. Nerve cells—or neurons—connect with other cells at a gap known as a synapse. That's where electrical pulses fire up, triggering the exchange of messengers called neurotransmitters. When we recall a memory, the same neurons from the original experience are reactivated and duplicate the moment.

To give an idea of the scope of these operations, your typical human brain has about 100 billion neurons, passing signals to one another via well over 100 trillion synapses. As one brain cell sends signals to another, it strengthens the synapse between them—a process known as potentiation—creating a bond that grows more powerful as the signals multiply. Studying a textbook in school, for example, drumming information into our heads by marking key passages in highlighter, stokes potentiation. And so, with each new experience, or repetition of a previous one, the brain rewires itself—a phenomenon scientists call neuroplasticity. Indeed, some areas of the brain can actually grow with repeated use. In a study of London cabbies, for instance, magnetic imaging tests showed that the drivers' hippocampi—which are heavily involved in spatial memory—became larger the longer they were on the job, navigating the city's streets.

These are the broad outlines of neuroscientists' understanding of memory, which was essentially a black box until the mid-20th century. A huge breakthrough came in 1957 when McGill University neuropsychologist Brenda Milner published a landmark paper based on the case study of Henry Molaison, a former assembly-line worker from Connecticut. Molaison had undergone brain surgery to relieve severe epileptic seizures—specifically, doctors had removed a portion of his medial temporal lobes from both sides of his brain. On one level, the operation was a success—the seizures subsided. But in another sense, Molaison's life, which lasted another half-century, was altered disastrously: His surgery had left him with anterograde amnesia, an inability to form new memories.

> Surgery on a man who suffered epileptic seizures left him unable to form new memories but revealed that brain structure was key to recall.

Molaison's surgeon consulted Milner and her colleagues at the Montreal Neurological Institute, who made a detailed study of the case. What they determined was that the operation had cut out much of the patient's hippocampus—the first evidence to suggest that the brain structure was critical to the formation of memories. On the other hand, tests showed that Molaison's implicit memory was undimmed. For instance, he was shown how to draw the image of a star by tracing its reflection in a mirror. Molaison could perform that task repeatedly but had no memory whatsoever of being taught how to do it. The result demonstrated that there are at least two separate areas of the brain involved with memory processing—the hippocampus and medial temporal lobe deal with explicit memories, and a different part of the brain (later discovered to be the basal ganglia and cerebellum) handles implicit, automatic tasks.

WHILE RESEARCHERS WERE identifying the "where" of memory in the brain, the question of "how" remained mysterious—and still does, to a significant extent. Around the time Milner was publishing her findings, the neuroscientist Eric Kandel began a decades-long quest to understand the biochemical mechanisms of memory storage, work that would earn him a Nobel Prize in Physiology or Medicine in 2000. Kandel has probed the

molecular underpinnings of short-term and long-term memory, including genetic changes that take place and help build new connections in the brain. He started out by picking up on Milner's work and studying the human hippocampus—how memories might be processed and stored there. But Kandel and his partner, W. Alden Spencer, found that analyzing such a complex structure in such a complex animal wasn't conducive to determining memory's basic essentials.

"In the 1960s, we went to a more reductionist approach," Kandel told the *New York Times* in 2012. "Instead of studying complicated mammalian brain cells, we studied the neural system of a simple animal, *Aplysia*, a snail with a very large nerve cell." Kandel subjected the foot-long mollusks to reflex tests, stimulating their nerve cells with electrodes to gauge the response. "We discovered that the snail's reflexes could be modified by several forms of learning, and that learning involved alterations in how nerve cells communicated with one another."

Kandel then studied the conversion of short-term memories into long-term ones—essentially the act of learning—and found that learning itself strengthened the brain. To illustrate: Short-term memory can hold about seven digits for about 20 or 30 seconds. The common example given is a 9-digit telephone number you don't have a chance to jot down; you try to keep it in your head just long enough to dial. What Kandel discovered was that when you actually learned the number, the synaptic connections involved strengthened. "It was astonishing!" Kandel recalled. "You could double the number of synaptic connections in a very simple neurocircuit as a result of experience and learning."

In studying the conversion of short-term memories into long-term ones, Kandel found that learning strengthened the brain.

Kandel and colleagues found that, unlike short-term memory, long-term memory requires the synthesis of new proteins. In the early 1970s, they found evidence to suggest that the neurotransmitter serotonin activates a messenger molecule crucial to memory known as cyclic AMP (cAMP). During the 1990s Kandel's lab identified the protein CREB as playing a key role in long-term memory storage by spurring synaptic connections. Meanwhile, other researchers had learned more about the alphabet soup that powers memory. For instance, two receptors, AMPA and NMDA, also play crucial roles inside the hippocampus, enabling learning and the synapse potentiation needed for long-term information storage.

Then in the early 2000s, Kandel and a member of his lab, Kausik Si, made what was considered a remarkable discovery: that another protein, CPEB, may be responsible for creating stable long-term memories. The surprise was that CPEB resembled a prion—which in its usual form is a toxic, self-perpetuating protein that may play a role in mad cow disease and Alzheimer's. CPEB, however, appeared to be a mutation that helps stabilize memories for the long term. Although other nonpathogenic prion-like proteins have been discovered in recent years, at that time the idea that anything like a prion, one of the most malevolent actors in the body, could do something beneficial was "nothing less than extraordinary," Rockefeller University's Robert Darnell wrote when Kandel and Si published their work.

When activated by a clue—say, a snippet of a song—our brains can retrieve a memory within a millisecond, but precisely how isn't known. Although imaging techniques show that the retrieval network involves interconnected areas of the medial temporal lobe, the specifics remain to be seen. Another open area of memory research is the role of the amygdala and emotion in making some emotionally charged memories more vivid; or, as some studies suggest, whether a strong emotion such as fear can actually have the opposite effect, altering or clouding memories we believe to be sharp and accurate.

As scientists follow these and other complicated threads of human memory, they are unraveling the tapestry of life itself. In Kandel's book *In Search of Memory*, he quotes Tennessee Williams's play *The Milk Train Doesn't Stop Here Anymore*: "Has it ever struck you . . . that life is all memory, except for the one present moment that goes by you so quickly you hardly catch it going? It's really all memory." ◻

Know Your Terms: A Memory Glossary

BY EMILY JOSHU

Sorting out the different types of memories can be confusing, but they all essentially fall into one of two categories: either declarative or implicit. Within those classifications, memories are deemed either short-term or long-term. Short-term memories last only up to roughly 30 seconds, while long-term memories can theoretically last forever, but they aren't all created equal.

Declarative Memory

Also known as explicit memory. This is a system of conscious memories requiring effort, such as being able to tick off all the items on a grocery list, recalling material you've read in a book or article, or remembering a friend's face or a phone number. There are three subsets:

1. Working memory

A short-term system for storing and processing limited amounts of information for 15 to 30 seconds; after that, the memory begins to decay. Tasks that function under working memory include calculating a tip, listening to a newscast or remembering lecture material for a test. Storage capacity is between four and seven items at a time. These could be four chunks of information, five words, six letters or seven numbers.

2. Episodic memory

A type of long-term memory for recalling past events, such as a road trip with a friend, a family reunion or an episode of a TV show you watched recently.

3. Semantic memory

A type of long-term memory for recalling general knowledge, such as knowing that 2+3=5, that George Washington was the first president or what the capital of your home state is.

Implicit Memory

Also known as nondeclarative memory, this long-term memory system unconsciously influences our current perceptions and behavior without effort or awareness. There are three subsets:

1. Procedural memory

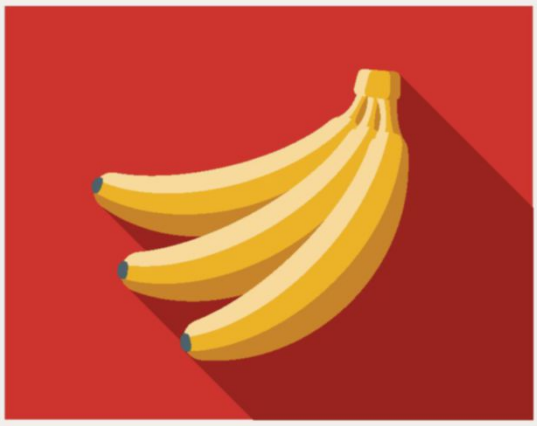
The memory of motor skills allows us to complete tasks we have previously learned and know how to do without trying, such as typing or riding a bike.

2. Priming

In this process, exposure to a stimulus triggers associated concepts that help a person recall an answer. Our brains are continuously forming associations between memories and ideas, such as the color yellow, a banana and a monkey. You're faster and more likely to come up with the word "banana" after you read the word "yellow."

3. Conditioning

Unconscious memory makes associations between two stimuli in this process. The classic example is Russian physiologist Ivan Pavlov's conditioning experiments with dogs. Before showing a canine a bowl of food, Pavlov rang a bell. Eventually, the animal salivated at the sound of the bell, knowing it was time to eat.



Understanding the Limbic System

Memories and emotions are linked through important brain structures

BY EMILY JOSHU

Memory is often described with evocative, romantic terms—a sepia-tinted snapshot or a beloved scrapbook. But this vital function is not something you can tuck under your arm like a diary. Instead, it comes to life inside the limbic system, an umbrella of brain structures controlling emotions, drives and learning processes. How do we remember where we left our keys, how to hit a baseball or when to eat or sleep? Here is a look at some key areas and what each does.

1 / Hippocampus

The hippocampus is a seahorse-shaped structure, embedded in the temporal lobe. This is where all conscious memories begin and where long-term memories are processed. According to Anthony Wagner, director of the Memory Lab at Stanford University, the parts of the brain that process the senses—taste, smell, sight, sound, touch—communicate with the hippocampus. "The hippocampus is positioned at the top of this information flow in the brain," he says. What we remember about an event, in effect, comes from a competition between typical memory traces. So when we touch something or see someone's face, the hippocampus helps us associate the sense with a memory.

2 / Amygdala

An almond-shaped structure of gray matter, the amygdala, nestled close to the hippocampus, controls emotional processing, memory and responses. It works in tandem with the hippocampus to connect memories with emotions such as fear. The amygdala activates when we're afraid of something, but the connection between the amygdala and the prefrontal cortex also helps to mediate the alarm by providing reasoning and context to control it or work through it. When this connection is damaged, it is more difficult to overcome fear or resolve disturbing recollections, a condition often seen in post-traumatic stress disorder patients.

3 / Prefrontal cortex

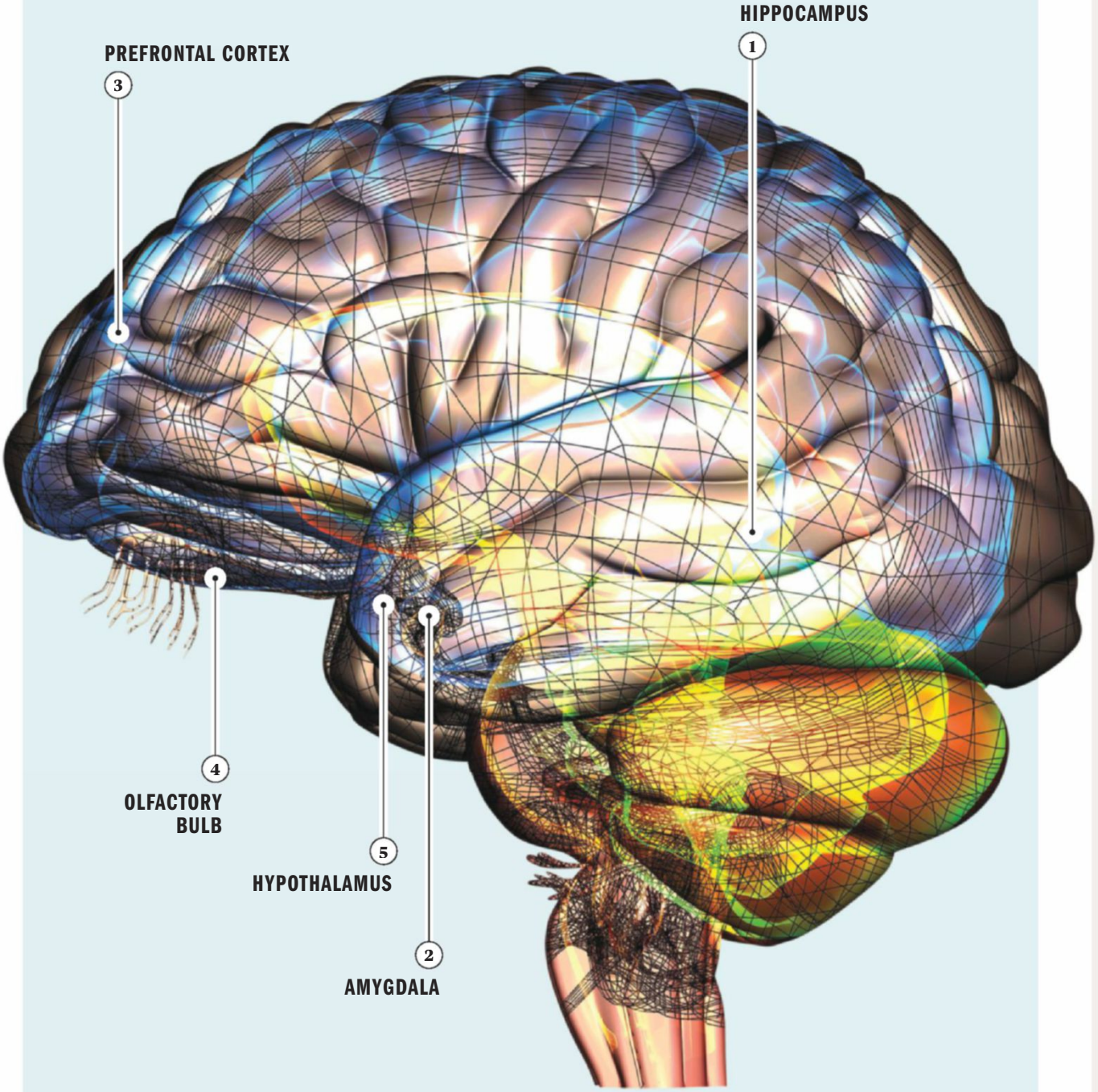
In the frontal lobe, the prefrontal cortex is responsible for working memory, the ability to remember and use information for reasoning and activities during a specific moment in time. These functions could include doing your taxes, baking a cake or even writing this article. The interaction between it and the hippocampus can be compared to a railroad: The hippocampus lays down new tracks—forming and retrieving memories—while the prefrontal cortex switches between tracks, gathering related memories to form context for an experience. The resulting memory is brief, staying in the back of your mind like a sticky note with a password on it.

4 / Olfactory bulb

The olfactory bulb is composed of receptors that send signals to the hippocampus. The receptors hang off a thin membrane, almost resembling a toothbrush grazing the nasal passage. This is the primary limbic structure for processing smell. When you walk into a room and detect something familiar, like your grandfather's cologne, that smell projects from the olfactory receptors into the hippocampus and amygdala. There are few memories that have smells strongly bound to them, so odor-related cues are powerful compared to visual or auditory cues, says Wagner. "We're not a very olfactory organism. We're very much a visual and auditory sort of species," he adds. Smell is atypical, so it's easier to recall odor-related memories.

5 / Hypothalamus

How is it that you know it is time to feed yourself, sleep or drink? Thank your hypothalamus, which controls involuntary functions like hunger, body temperature, fear, sexual responses and hormonal balances, brain activities that keep us alive. However, sometimes the hypothalamus malfunctions and your body forgets to tell you when to stop doing these things. People with Prader-Willi syndrome are examples of this, their hunger insatiable because their bodies never remember to feel full. Even though these are not functions that we actively think about, they still are a part of memory.


HIPPOCAMPUS
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PREFRONTAL CORTEX
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OLFACTORY BULB
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HYPOTHALAMUS
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AMYGDALA

A POWERFUL SCENT
The early 20th-century physician Edward Bach believed the scent of honeysuckle could help people break from negative memories and perseveration. The fragrance can also accentuate fond thoughts of the past—as it did for the author of this story.

The Time-Bending Magic of Smell

Odor-evoked autobiographical memories derive their power from the way they are processed in the brain

BY RICHARD JEROME

In the shadow of the grand apartment houses along Central Park West, an aroma of honeysuckle wafts through the thick summer air and suddenly I'm a boy again in our New Jersey backyard, where a cluster of white petals surrounds the grave of our fox terrier, who died when I was 10. A garlic breeze from a local restaurant carries me miles and years away to Boston's North End, dining with my wife-to-be at an Italian place where the owners lived in back and they served up the best chicken parm ever; a cinnamon stick conjures the late, lamented Café Figaro in the Village, where I've grabbed a window table overlooking Bleecker Street, watching till she rounds the corner from dance class and we sip cappuccinos into the night.

We've all had the experience, a scent that evokes vivid, visceral memories, as if an internal time machine were transporting us back to events and places in our deepest past, recalling them to life with profound urgency and immediacy. It's a phenomenon that inspired one of the most celebrated passages in Western literature, a scene early in Marcel Proust's seven-volume masterpiece, *Remembrance of Things Past*, when the narrator bites into a madeleine biscuit dipped in Linden tea and the taste unleashes a sudden flood of reminiscence that carries him back to early childhood. He remembers the aunt who used to fix him madeleines the same way; the old, gray house where she roomed; flowers in the garden and water lilies on the river Vivonne; the parish church, modest homes and people of Combray, the fictional village where the narrator grew up. Proust's observations were so compelling, they inspired a cottage industry of psychological research into what is referred to as the Proust phenomenon—the ability of odors to cue vivid autobiographical memories.

Why do scents work such time-bending magic, peeling away decades instantaneously as no other human sense can? The sight of fall foliage, the sound of a train whistle, the feel of Silly Putty—all, to varying degrees, can spark remembrance of things past. But it seems that only our noses allow us to relive events, however remote or ordinary, in the moment. These recollections do indeed hold a unique place in our psyches, writes cognitive neuroscientist Rachel Herz, an expert on the psychology of smell. They extend deeper into our past,

"specifically clustered in the first decade," Herz notes, and also pack a more potent emotional wallop than recollections triggered by sights, sounds and other sensory cues.

On the flip side, potent odors can revive incidents we'd rather forget, in the worst cases inducing severe distress and even all-too-vivid flashbacks, particularly in people who already suffer from post-traumatic stress disorder. For instance, the smell of alcohol on a man's breath or a particular aftershave might cause the survivor of a sexual assault to relive the horrific experience. A widely cited series of case studies published in 2003 by PTSD researchers Eric Vermetten and J. Douglas Bremner found in one patient that the scent of diesel from a neighborhood fire sparked intense feelings of guilt and nausea. As it turned out, the man had served in Vietnam and witnessed a vehicle accident in which fellow soldiers had died in a burst of flames.

"Odor-evoked autobiographical memories," as scientists refer to them, derive their special power from the particular way they're processed in the brain. The olfactory system is the only sensory apparatus that does not feed its incoming signals through the thalamus—one of the brain's major relay stations. Rather, scents and tastes are directly connected to the limbic system, a collection of brain structures important for emotion, behavior, motivation and memory. Specifically, when you smell something, the odor gets routed through the olfactory bulb, a neural structure that analyzes scent.

Beginning inside the nose and running along the bottom of the brain, the olfactory bulb is closely connected with two other limbic-system sites—the hippocampus, the seahorse-shaped part of the forebrain responsible for the functions of memory and learning as well as the perception of space and time; and the amygdala, a small mass of gray matter, resembling an almond, that, among other things, is involved in the experience of emotions. It's this unique proximity and access to the limbic system that underlies the particularly evocative ability of odors to generate memory and emotion. While the human body has just two receptors for sight and four for touch, it has about 350 for scent, allowing it to detect a trillion different smells.

All in all, then, smell is a formidable capacity, albeit one we tend to underestimate. "Humans are visual creatures—our external environment is predominantly represented by brilliant and colorful scenes acquired through our eyes," says Afif Aqrabawi, a postdoctoral associate at M.I.T. who specializes in the link between scent and memory. "This makes it difficult for us to appreciate the importance of our other senses. Nevertheless, the majority of the animal kingdom must rely on the sense of smell to navigate their surroundings. Olfaction is essential for most organisms to find food, predators and mates." Indeed, adds Aqrabawi, "chemosensation"—the capacity to sense chemical substances, an evolutionary precursor to olfaction—"serves as the primary means of external experience and communication for even the most elementary forms of life, such as bacteria and protozoans."

Scent memories pack a more potent emotional wallop than recollections triggered by sights, sounds and other sensory cues.

A growing insight into the scent-memory connection has great potential for enhancing human health, opening the door for new therapies and cures. For example, a large body of work has shown that one of the first signs of Alzheimer's and Parkinson's is that patients suddenly find themselves unable to identify odors or pinpoint when and where they smelled them. Researchers believe that finding the roots of that olfactory deficit may hold a key to treating those afflictions.

There are also possible psychic benefits. In one promising study, neuroscientist Artin Arshamian of the Karolinska Institute in Sweden found in a survey of young adults that autobiographical memories cued by odors tended to be not only more intense but also more positive than recollections cued by verbal labels for the same odors. A 2013 study led by Japanese researcher Masahiro Matsunaga found that when men and women were exposed to a particular perfume they associated with a pleasant memory, the fragrance gave them

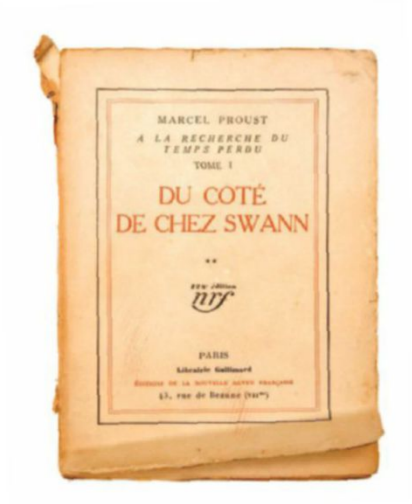
Researchers at the European Centre for Taste Sciences examine a newborn to see if the child remembers strong scents, such as anise and curry, that were part of the mother's diet.

an elevated sense of comfort and happiness and a decrease in anxiety.

With this in mind, Herz suggests that the evocative power of odor could make it a valuable clinical tool. "Many people intuitively note that odors have the potential to elicit comfort," writes Herz in the journal *Brain Sciences*, such as when a person "sniffs a garment worn by a loved one they are separated from." She adds that "nostalgia—reflecting upon one's personal past—has been shown to have many beneficial psychological consequences." Substantial research has demonstrated that this kind of thoughtful reminiscence "increases positive affect, bolsters self-esteem, strengthens the connection between one's past and present, produces feelings of social connectedness, elevates optimism and infuses life with meaning."

Who can argue with that? Interestingly, the Matsunaga study determined that whereas one usually associates nostalgic feelings with music—the tune that takes you back to childhood, your first love or whatever you consider the good old days—odors actually inspired more than twice as many happy reveries as did musical excerpts. The effects are physiological as well. When a smell triggers an exhilarating or exciting memory, it can make the heart race and spark a rush of adrenaline. Another research survey found that when men and women from ages 29 to 50 self-selected a scent that elicited a pleasant, soothing autobiographical memory—say, a particular flower—their breathing grew slower and more relaxed. The remarkable implication: To feel better, happier, more exhilarated, it may literally be as simple as stopping to smell the roses—or the pine or freshly cut grass or whatever scent evokes your satisfying autobiographical memories.

For me, it's a certain perfume that transforms me once again into a toddler playing with the vintage atomizer on Mother's vanity. She's gone for decades now, but that scent brings Mom back, if only for a fleeting, fragrant moment. □



EXCERPT

The Power of a Madeleine

In one of literature's most famous passages linking taste and memory, Marcel Proust's hero bites into a cookie and is transported to his childhood in Combray, France

No sooner had the warm liquid, and the crumbs with it, touched my palate than a shudder ran through my whole body, and I stopped, intent upon the extraordinary changes that were taking place. An exquisite pleasure had invaded my senses, but individual, detached, with no suggestion of its origin. . . . Whence could it have come to me, this all-powerful joy? I was conscious that it was connected with the taste of tea and cake, but that it infinitely transcended those savours, could not, indeed, be of the same nature as theirs. Whence did it come? What did it signify? How could I seize upon and define it?

And I begin again to ask myself what it could have been, this unremembered state which brought with it no logical proof of its existence, but only the sense that it was a happy, that it was a real state in whose presence other states of consciousness melted and vanished. I decide to attempt to make it reappear. I retrace my thoughts to the moment at which I drank the first spoonful of tea.

And suddenly the memory returns. The taste was that of the little crumb of madeleine which on Sunday mornings at Combray (because on those mornings I did not go out before church-time), when I went to say good day to her in her bedroom, my aunt Léonie used to give me, dipping it first in her own cup of real or of lime-flower tea. The sight of the little madeleine had recalled nothing to my mind before I tasted it; perhaps because of those memories, so long abandoned and put out of mind, nothing now survived, everything was scattered; the forms of things, including that of the little scallop-shell of pastry, so richly sensual under its severe, religious folds, were either obliterated or had been so long dormant as to have lost the power of expansion which would have allowed them to resume their place in my consciousness.

And once I had recognized the taste of the crumb of madeleine soaked in her decoction of lime-flowers which my aunt used to give me immediately the old grey house upon the street, where her room was, rose up like the scenery of a theatre to attach itself to the little pavilion, opening on to the garden, which had been built out behind it for my parents; and with the house the town, from morning to night and in all weathers, the Square where I was sent before luncheon, the streets along which I used to run errands, the country roads we took when it was fine. And just as the Japanese amuse themselves by filling a porcelain bowl with water and steeping in it little crumbs of paper which until then are without character or form, but, the moment they become wet, stretch themselves and bend, take on colour and distinctive shape, become flowers or houses or people, so in that moment all the flowers in our garden and in M. Swann's park, and the water-lilies on the Vivonne and the good folk of the village and their little dwellings and the parish church and the whole of Combray and of its surroundings, taking their proper shapes and growing solid, sprang into being, town and gardens alike, from my cup of tea.

When odors and tastes trigger strong autobiographical memories, scientists call it the Proust effect. Here, the novelist circa 1900. Opposite: The madeleine story appears in Swann's Way, *the first volume of* Remembrance of Things Past, *published in 1913.*

Elephants understand basic math and can keep track of relative sums.

An Elephant Never Forgets

Averaging about 10½ pounds, the pachyderm brain is the largest among all land animals, with a memory that rivals those of apes and dolphins

BY COURTNEY MIFSUD INTREGLIA

SHIRLEY AND JENNY HAD NOT LAID eyes on each other for more than two decades, but when the old friends were brought together for a surprise reunion in Hohenwald, Tenn., the moment was beyond dramatic. It was earsplitting. First Shirley started bellowing, then Jenny. Carol, who witnessed the moment, described the sounds as "roars."

No, Jenny and Shirley weren't long-lost girlfriends. They were retired circus elephants who had worked together briefly, been separated and suffered abuse. Now, they were side by side again at an animal sanctuary and overjoyed. "They were trying to climb in with each other and frantically touching through the bars," wrote Carol Buckley, founder of the refuge, at the time. "I have never experienced anything even close to this depth of emotion," she said.

It turns out that what they say about elephants is true. Not only do they have better long-term memories than their four-footed peers, an elephant's brain—at 10½ pounds of matter—is the largest among all the land animals. Some elephants remember injuries and hold grudges against whoever hurt them. They recog-

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Bottlenose dolphins have procedural memories that last for years.

nize their reflections in a mirror, suggesting self-awareness, and some even know their handlers by sight after being separated for years. In terms of sheer intelligence, pachyderms are up there with dolphins, apes and people, perhaps because inside their craniums sit 257 billion neurons, about three times the number contained within the human skull.

Granted, elephant brains are organized in a different way than those of their smaller hominid friends, which is why they aren't actually smarter than people. But they are humanlike in many respects. Elephants adapted to life in African forests and on savannas about the same time humans did, immigrated to Europe and Asia and evolved to live long and often migratory lives in complex societies. They also developed a sophisticated communication system and experienced a dramatic increase in brain size for the same reason as people—they live a very long time, normally 60 to 70 years. Before embarking on a group outing, they even debate which direction to take, according to Phyllis Lee, author of a study of elephants in Kenya's Amboseli National Park. "It's wonderful to watch," she told a newspaper, "a real process of negotiation."

Elephants are of course not the only brainiacs of the animal kingdom. Dolphins communicate through distinct whistles and clicks that may serve as names or a type of language. Adolescent chimpanzees have outperformed humans on certain memory tests. A few years ago, a group of goats figured out how to operate a lever to reach a piece of fruit—and remembered the task 10 months later.

But elephant intelligence awes us uniquely, perhaps because they display such humanlike emotions as empathy, grief, humor and compassion, and they behave like us in many situations. Elephants have been seen using heavy branches to weigh down fences so they can climb over them. They've brandished sticks to ward off attackers.

Legends of elephant memory and intelligence date back thousands of years, and scientists have long observed just how clever the animals can be in their natural habitat. But until the past 20 years or so, there were few carefully controlled experiments

to compare the memory capacity of elephants to that of their animal-kingdom peers. Now, in addition to probing how elephants use their smarts during droughts and to protect themselves when threatened by enemy agents, researchers are designing studies to evaluate how the animals use their memories to learn to use tools, to work as a group and to problem-solve.

In a 2011 study of Kandula, an elephant at the National Zoo in Washington, D.C., researchers hung fruit-dipped bamboo branches within and just out of trunk reach to see if he could learn how to access them. This was a test other elephants had failed, in part because researchers had given their subjects sticks to nab the fruity bamboo. The problem: When the elephants curled their trunks around the sticks, their sense of smell was compromised. Earlier participants could not smell the snack to find it. Kandula, however, aced the trial, moving a large cube in his yard to use as a stepping stool to reach the bamboo. He learned to do the same with a tractor tire and giant blocks.

Such research builds on traditional studies that have established how elephants' memories help them navigate climate events and other hardships. For example, in 1958 a severe drought ravaged Tanzania's Tarangire National Park, home to a large elephant population. Almost 40 years later, when drought conditions returned, the Wildlife Conservation Society of London studied the migration patterns of three herds in the park. Among other findings, the researchers noted that the herd with the youngest matriarch, age 33, remained in the northern area of the park, where there was little water or food, and two thirds of the calves died.

But the older matriarchs, ages 45 and 38, who had survived the trauma of the 1958 drought, fared much better. They led their packs out of the northern portion of the park, theoretically to food and water elsewhere. Fewer than 10% of these calves died, prompting researchers to hypothesize that the older elephants remembered the location of resources from decades earlier.

The matriarchal structure of elephant society is, in fact, crucial to the herd's survival. Though males leave the group when they reach sexual maturity, between 12 and 15, related elephant mothers and their offspring stay together for life. They form a tight-knit unit, communicating with chirps and rumbles and caring for one another's calves. Members look to the matriarch, typically the largest female in the herd, for guidance, and she may oversee anywhere from 12 to 100 elephants over the course of a day, depending on the availability of water and food.

The matriarch not only knows each elephant; she keeps tabs on them as the herd travels, according to research conducted by Scottish psychologist Richard Byrne. After collecting urine samples from elephants living in a park in Kenya, Byrne placed them in front of the matriarchs. The females examined the samples with their trunks and started acting up when the urine did not come from their herd. The elephants also reacted when the urine was from a family member they thought was far away. "Imagine taking your family to a crowded department store and the Christmas sales are on," Byrne told *Scientific American*. "What a job to keep track of . . . four or five family members. These elephants are doing it with 30 traveling-mates."

> Imagine taking your family to a busy store at Christmas and keeping track of four or five kids. The elephants do it with 30 travel mates.

Which raises the inevitable: Can elephants sometimes best us at problem-solving? The answer appears to be a qualified yes—as illustrated by Neua Un, a Thai elephant who participated in a 2011 test of memory and cooperation. One of a dozen pachyderms at a conservation center, Neua Un was paired with another elephant and the two were tasked with pulling a table toward them with ropes. The animals had to learn to perform the task as a team; otherwise the rope would unravel. Neua Un, however, figured out she could use her foot to hold the rope so that her partner had to do all the work. The shortcut, which spoke to the idea that animals with a great capacity for memory also seem to be astute in terms of ingenuity, hadn't occurred to lead researcher Joshua Plotnik. While he suspected Neua Un discovered the cheat by accident, Plotnik was impressed nevertheless. "It speaks volumes to the flexibility of elephant behavior," he told NBC, "that she was able to figure this out and stick to it." ◻

Forget-me-nots symbolize remembering during partings or after death and a connection that lasts through time.

The Essential Act of Being Human

The paradox of memory is that we can summon it, but it can control us. It is exquisite and it hurts

BY STEVE LEDER

Because I am a rabbi, I have been visiting people in hospitals for nearly 40 years. One of the best techniques I learned long ago to help someone who is suffering terribly is to take that person on a sort of mental vacation back to happier times. "When was your first kiss?" I might ask. "Who was she? Do you know where he is now? What was the greatest vacation you ever took? Do you remember the first time you ever laid eyes on your wife? What went through your mind? Best meal you ever ate? Funniest thing you ever did? Take me back . . ." It is amazing to watch how memories lift people above their current sorrow into the transcendent meaning embedded in reminiscing. And it works every time.

On the holiest day of the year, during a service devoted to remembering loved ones who have died (it's called *Yizkor*), I tried something similar to my hospital mental vacation exercise, but this time from the pulpit. "Close your eyes," I said to the congregation of 2,000 people seated in the quiet beauty of the sanctuary. "Close your eyes and breathe in deeply. Breathe out and relax. Breathe in deeply again. Breathe in peace. Breathe in quiet. Now, place yourself in a comfortable room in your home or wherever you choose and invite into that room a loved one who has died. Bring him to life again in your mind. Bring her to life again in your mind—in your memory. See her. See her skin, her hair. Feel his whiskers against your cheek. See his smile and his eyes. Be with her. Speak to her. Tell her what you wish for her. Give her your blessing. Now allow her to leave the room. Be with him. Speak to him. Tell him what you wish for him. Give him your blessing. Now allow him to leave the room. Breathe deeply—and when you are ready, open your eyes." Halfway through this visualization, the room was awash in tears, hundreds of grown men and women, weeping, longing . . . remembering.

To remember is the quintessential act of being human. Not in the instinctual, mindless way of salmon swimming upstream to spawn or squirrels finding their long-ago-hidden acorns, but to use memory in a way that summons the past into the present and brings the dead back to life—willfully, specifically, tearfully.

My father died peacefully in his sleep after a 10-year battle with Alzheimer's. It is a disease that kills

people twice: once when the mind is lost and once when the body mercifully wears out. Both deaths are painful, but each in its unique way. The first caused my dad to forget who he was and who everyone who loved him was. In a sense, that forgetting meant that for him, neither he nor we existed any longer. There was a new he and a new we created in the vacuum of his mind; no one and nothing was the same.

That is, unless and until I chose to make use of the most precious of all gifts—my memories. In order to bring my father back to life, I merely had to remember all those simple things that he loved: A slice from a perfect avocado. A sunny day. Hank Williams and Johnny Cash. A joke—the dirtier, the better. Watching *All in the Family* in his vibrating Naugahyde chair, peeling an orange into a perfect spiral before handing out slices to each one of his five children as if we were a nest of hungry birds.

He didn't know or care about sports or hobbies or new gadgets like other dads. But he could back up a semi and operate a crane. My dad taught me to love nature, fishing, pancakes, corned beef hash and Mom's soups. Mostly Dad taught me to enjoy a moment during that moment. So many times when he was eating something delicious and plenty of it, or when we were walking in the sunshine somewhere beautiful, he would just look around and ask rhetorically, "Are we livin'?"

So many times my dad would be walking in the sunshine somewhere beautiful, and he would look around and ask, "Are we livin'?"

The last real conversation I remember having with my dad before thinking became hard work and confusing for him was about my fundraising for the temple. Mom was there too. We were sitting around that Formica table in the Palm Springs kitchen where they had sat together all those years drinking pots of tea from the stainless-steel thermal container and playing countless rounds of Rummikub.

It was at that table Dad asked, "How's work going?" And I told him, feeling a little sorry for myself, that it was really hard to raise all the money we needed, and I wasn't sure I could do it. He looked at me, smiled and said, "*Az m'schtuptis, gatis*—If you push, it goes." Almost everything Dad said was a double entendre and dirty. So he wasn't just talking about fundraising. That was him: simple, funny and right. Whatever your goal, just keep pushing. He was crude—and hilarious. And when I remember it all, he is those things again.

But there is more to memory than laughter and love. Weeks after viewing him in a plain pine casket—vacuous, cold and dead—I want to forget that image of my dad. I can't. Weeks after shoveling earth onto that same casket with a thunk, I want to forget that sound. I can't. *I don't want to remember. I don't want to remember. I don't want to remember*, I tell myself. Yet I cannot forget the ugliness or the surreal power of his death.

And if Freud was even partially right, there is a world of memories not about my dad's death but about his life that, try as I may, I can only sort of forget. Harsh memories of discipline and anger, anxiety and fear repressed and banished to the basement of my subconscious are constantly pounding on that same basement ceiling with a broomstick, reverberating in ways mysterious and dark in the core of my conscious life, animating my own flaws, dysfunction and vulnerabilities. That is the secret truth of memory: We summon it, yet it controls us, it is exquisite, and it hurts—like being caressed and spat on at the same time.

WHENEVER A VILLAIN is mentioned in classical rabbinic literature, his name is followed by an acronym for the words "May his name be blotted out." In the minds of the ancient rabbis, the worst thing one could wish upon another, the curse of curses, was that he or she be forgotten. And yet within that very curse the name of the villain is nevertheless perpetuated. We can wish that evil, sadness and ugliness be forgotten, but saying "Don't think about it" is to think about it—an attempt at squaring a circle; a fruitless, impossible denial of the constant that is memory itself. When Santayana said, "Those who forget the past are doomed to repeat it," he was only half right. For it is also true that those who only remember the past are also doomed to repeat it. This is the trap of memory that causes so much pain in so many families.

I often counsel people to forgive the sins of others who are truly sorry for what they have done. More

To stay connected to loved ones who've passed away, some people write them letters or imagine the advice they would give.

times than not, people know they should forgive but say they just can't. "Rabbi, maybe she's sorry now, but you have no idea what she did. How she hurt me. How he cut me down. How he turned his back on me when I needed him most. I want to forgive, but it's too hard."

Long ago I learned that what the unforgiving are often really saying is not that it is impossible to forgive but that it is impossible to forget. We have no choice but to remember pain, the same way we have no choice when asked not to think about a pink elephant, but far worse. Such is the grip of memory. It is a force unlike any other in our lives.

When a non-villainous person dies, a different wish is suggested when his or her name is mentioned; a beautiful wish: "May his memory be a blessing." Seemingly different, these two aphorisms, "May his name be blotted out" and "May his memory be a blessing," speak the same truth—to be remembered is to live beyond the grave in ways sublime and terrible. Of course, sooner or later we are all "blotted out." Kafka said, "The meaning of life is that it ends," and that is no less true of memory. When it is gone, we are gone. We don't like to think about it, but eventually, in a generation or two or three or four or five, there will not be a single person left on earth who remembers us. When that day comes, we are truly dead.

In the meantime, how else can we hold on to the people we love, to the past that defines us, the offenses that wound us, or the laughter and the love that warm us? How else can we hold on to anything in a world whose centrifuge of speed and stress tries to whirl us all apart? What else can I do when I miss my dad so much? Nothing, other than embrace this blessing, this curse, this imperfect gift, this burden, this holy vessel: memory. □

Steve Leder is the author of five books, most recently For You When I Am Gone: Twelve Essential Questions to Tell a Life Story.

CHAPTER 2

WHY WE FORGET

Many of us are anxious about losing our memories, but letting go of certain information allows us to store what is important.

Forgetting Childhood

Our memories shape and define us. So why do our earliest experiences start to fade when we are just 3 years old?

BY PATRICK ROGERS

I would like to share an episode from my early youth, a minor medical emergency, quickly resolved. I was a healthy child and on schedule with regard to all developmental milestones when, sometime before my second birthday, I began to experience sharp pain in my ears. I shrieked in my crib and clawed at my ears with my hands. Multiple trips to the pediatrician did nothing for the pain until I was admitted to the local hospital, where a surgeon performed a simple procedure to alleviate the pressure behind my eardrums. I was cured. Still, my mother recalls holding me in her arms all night long, so worried was she about her youngest child.

I, on the other hand, remember nothing. The details of this childhood trauma, in addition to everything that happened in the two years that preceded it and all of the events of my life in the 12 months or so that followed, are completely lost to me. In fact, I remember nothing until my family moved the following year to another town, where a neighbor's cat wandered into our yard and sat beneath a shrub. That is my indelible, and rather mundane, first memory. But before that, the sights and smells, the taste of

Our earliest memories begin to fade by age 3½, a time when a core long-term memory mechanism—the hippocampus—is still maturing.

For a trial of infants' long-term memory, 1-year-olds were tested in an unusual environment and an ordinary room.

favorite foods, the birthday presents and bug bites of my early youth—all are completely gone.

Scientists have a name for this: childhood amnesia. As infants, even without the language skills to describe experiences, we can store information in our brains and retrieve it for later use. Yet beginning at the age of about 3½ years, the memory chips of the human mind begin to experience failure. Our childhood recollections start to fade, and by the age of 7, they are almost entirely erased, so that a teenager recalls no more of her earliest years than a 50-year-old woman does.

It's no surprise that we retain some facts and experiences but forget the others. "The first thing that we have to accept is that most of our memories don't last, and that's true across our lifetime," says Robyn Fivush, a professor of psychology at Emory University who studies autobiographical memory. "Are they completely forgotten? That's kind of controversial because how do you say they can never, ever be remembered again? But certainly they become very, very difficult to access."

To the average observer, the timing of this accelerated loss of data during the preschool years is also confounding. It is the very time of life when the brain develops rapidly in both size and complexity. Its weight jumps from 25% of adult size at birth to 75% by age 2, suggesting more room for memory and cognitive power. Yet the brain's development is uneven: most of the cells of the hippocampus, the center of memory and emotion in the brain, are formed before we are born, for instance, while the area that joins the hippocampus to the brain's cortex, the dentate gyrus, doesn't mature until after the first year of age. In the prefrontal cortex, another of the brain's memory makers, the density of synapses (the specialized connectors that allow the brain's messages to circulate) surges between eight and 24 months.

A young person's brain is not fully mature, with all of its memory components working in tandem, until the mid-20s. What happens in the years leading up to that point? Neuroscientists have proposed that synapses formed in that early, busiest period of development may be overwritten by fresh neural

connections, essentially creating a blank slate for the fully forming human brain to populate with a lifetime of new recollections. Other theories focus on the lack of language and immature cognitive skills as reasons that the pre-3 set can't seem to hold on to their thoughts and feelings into adulthood.

The episodes of our lives—our autobiographical memories—are what shape our sense of self and define us. Although the literature includes many examples of adults who do have precocious memories of events like the birth of a sibling, these sequences of personal history are largely elusive, which makes childhood amnesia, a condition that is considered universal, so compelling to study today. "Knowing how autobiographical memory develops is critically important to understanding ourselves as psychic beings," wrote psychologist Patricia Bauer of Emory University in a 2014 study that plotted the onset of childhood amnesia. "Remembering yourself in the past is how you know who you are today."

People have grappled with the puzzling void of early youth for centuries. Swiss philosopher Jean-Jacques Rousseau observed in the 1700s that children lack "true memory," and the Russian novelist Leo Tolstoy more than a century later sought to reconcile the period of his life he did not remember with his sure knowledge that it had existed. "It is a strange and awful thought that from my birth to the age of three, during which time I was suckled, I began to crawl, to walk, and to speak," Tolstoy wrote in his essay "First Recollections." "Yet in spite of all my efforts I cannot find anything to remember except the two facts of swaddling and bathing. When did my existence commence?"

When the father of psychiatry, Sigmund Freud, coined the term "childhood amnesia" in 1905, he described it as a self-defense mechanism that cast "a veil" of forgetfulness over disturbing sexual and Oedipal memories. Contemporary researchers have taken a more expansive view of childhood amnesia—we lose more than just lusty memories, after all—and focused on language and the physical development of the brain when examining the inability of young children to form an autobiographical account of their lives.

When we look back at distant memories, they tend to be fragmentary and vague and are frequently laden with emotions. Even when we recall a vividly detailed flash of awareness, like a grandmother's polka-dot dress, the background and context are indistinct. In real time, however, infants and toddlers probably experience sharp and detailed recall. They have the capacity for short-term memory, which allows them to repeat simple sequences like drinking from a bottle, as well as the type of long-term memory that scientists call declarative or semantic, which includes knowledge of facts.

Young children don't need words to convince us that they can remember: just ask a proud parent whether the face of their infant lights up every time they walk in the room, or note how a baby may become fussy in the doctor's office waiting room, suggesting unpleasant associations with the place. Proof that pre-linguistic children have memories independent of physical cues has arrived only relatively recently. In a landmark study published by Emory's Robyn Fivush in 1987, children as young as 2½ years old were observed reaching back into their pasts to pluck out events that had occurred up to six months earlier, including one little boy who recollected taking a glass ornament from the Christmas tree that broke and cut his hand.

> By the age of 7, our first memories are almost entirely erased, so that a teen recalls no more of her early childhood than a 50-year-old.

"That sounds like a very elaborate narrative, but what he actually said was 'ball' and 'cut' or something along those lines. It took the adult to say, 'What ball?' and 'Did it break?'" says Fivush, who believes that the memories that stay with us from early childhood are those that have been integrated into our autobiographies. "Did the boy have a memory of this event? Yes. Was he able to put it into a more coherent narrative structure that may allow him to remember it for longer? No."

In a subsequent research paper in the U.K., 12-month-old babies were shown how to play with a set of toys without being allowed to actually touch them. When the infants were tested again four weeks later, half of them retained the know-how to play with

the toys. If people in the past theorized that childhood amnesia occurs because babies don't have the words and sophisticated cognitive power needed to form memories, it's now evident that even preverbal infants can encode, store and recall lasting memories, just not permanent ones.

Less is known about why the library of the young mind rapidly depletes itself at about the same time children start school. When Emory University's Patricia Bauer and her team set out to probe the dynamics of childhood amnesia in 2013, they recruited more than 80 3-year-olds in Minnesota. The toddlers were questioned by their own mothers about six recent events—camping, birthday parties, visits to relatives—as researchers looked on. The children then returned to the lab years later at specific ages, from 5 to 9, to have their memories tested again.

On their second visits, children between the ages of 5 and 7 could still recall about two thirds to three quarters of what they had remembered at age 3, yet by age 8 or 9 they could summon only about a third of their early recollections. As seen before, the young subjects were robust memory makers, forming strong recollections that lasted for up to four years. But then they experienced a die-off of memories after the age of 7 that would be considered catastrophic in adults. Bauer has proposed that early-childhood memory is a two-sided coin in which forgetting is just as important as remembering: "Indeed, it is the apparently 'off the charts' rate of forgetting that makes the phenomenon so mysterious," she wrote in the American Psychological Association's *Psychological Science Agenda* in 2004.

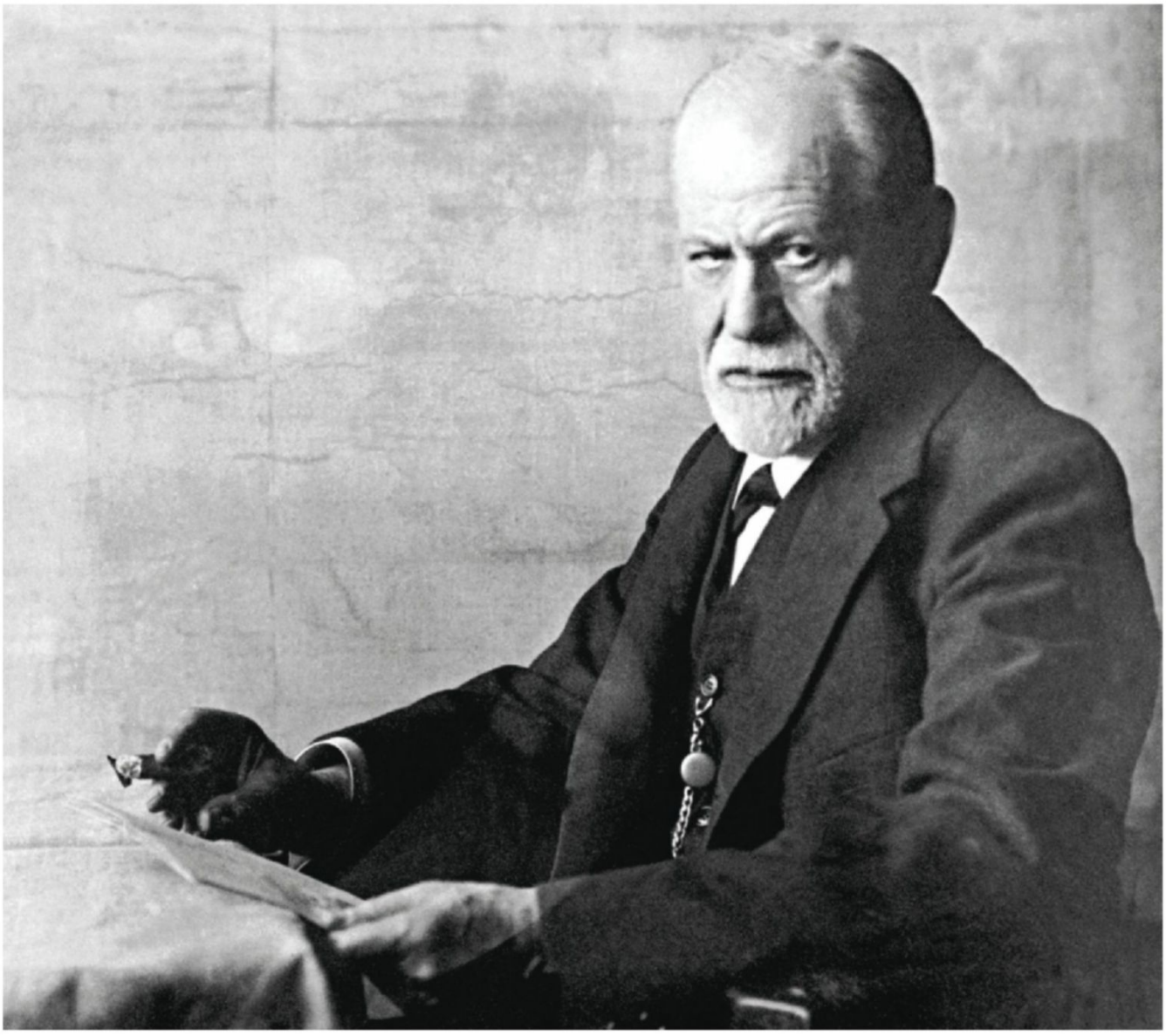
What, then, makes us forget? Underneath the cranium, neuroscientists are looking at the physical building blocks of human recollection, the electrically excitable neurons that join together to form synapses. In the hippocampus, these new cells are constantly generated in one area, the dentate gyrus, and then migrate to another, the granule cell layer, where they join the existing circuitry. In studies of mice, researchers artificially sped up neuron production in this part of the brain. But in accompanying memory tests, the mice showed a higher rate of forgetfulness as memory capacity was physically growing. The researchers from Toronto's Hospital for Sick Kids hypothesized that their brains were remodeling at a rapid rate, just as humans do in early childhood, and shedding existing memory in the process. Out with the old, in with the new.

Bauer's study of childhood forgetting in 2014 also provided clues about the critical role that language may play in determining which bits of information make the jump from short-term to long-term memory and which are left to oblivion. Children whose parents encouraged them to elaborate on their recollections by saying "Tell me more" or "What happened?" had richer recall later compared with those whose parents confirmed or repeated their replies. The act of pondering and articulating the facts of our lives, of rehearsing our own autobiographies, appeared to mark certain facts and experience as candidates for memory consolidation. Units of information that arrive in the brain separately from the sensory organs are woven together into multifaceted memories that are harder to forget—the memory skill that the little boy with the Christmas ornament hadn't yet mastered.

Children whose parents encouraged them to elaborate on recollections, saying, "Tell me more," had rich recall later.

Language also plays a role in the generation of false memories from childhood, specifically when other people script the stories. The Swiss psychologist Jean Piaget famously insisted that his first memory was of his nurse fending off a kidnapping attempt on the Champs-Élysées when he was still in the pram. When Piaget was 15, the nurse admitted she had invented the story, and even then Piaget could still picture the scene in detail.

This type of "memory of a memory" occurs often. It's not unusual, for instance, for siblings to argue over which one was the girl who flew headfirst from a swing at a family picnic and landed in a puddle while wearing her favorite dress. In a 2018 survey of more than 6,000 adults in the U.K., most reported their first memory, predictably, in the first half of the third year of life—which is when researchers have shown that first memories usually fall. Those who departed from the norm tended to veer on the young side, with nearly 2,500 (about 40%!) report-



Psychoanalyst Sigmund Freud, here in 1926, believed childhood amnesia was caused by the repression of traumatic, psychosexual memories.

ing memories from before the age of 2. Almost 15% said they could recall events from age 1 and earlier—a "highly improbable" occurrence, according to the study's authors from the departments of psychology of three British universities.

As an explanation of their unexpected findings, the U.K. psychologists proposed that people take imagery from photographs, home videos and childhood events and combine them with a fragment of visual information. "Over time, this combination of imagery and fact begins to be experienced as a memory," wrote lead author Lucy Justice on the website The Conversation. "Perhaps, for reasons not yet known, we have a psychological need to fictionalize memories from times of our lives that we are unable to remember. For now, these 'stories' remain a mystery."

A mystery, perhaps, but not really a surprise. We wouldn't have Ancestry.com and write memoirs if we didn't feel a strong impulse to fill in the facts of our beginnings. For every person who tries to fill the lapses of early childhood with invented or borrowed memories, there are others who have no such memories and worry there's something wrong with them. There's not. "Our experiences, all of our experiences, impact our bodies and our brains, whether we remember them or not," says Fivush, who recalls a subject in a memory study who swallowed a chicken bone at the age of perhaps 14 months and was taken to the ER. Though the girl had no recollection of the incident later, she became hysterically frightened whenever her parents served chicken for dinner. "We can say, 'I have no idea why I'm like this,' says Fivush, "but you look in the medical record, or family history, and there it is." □

Meck, second from right, posed with her brother Rob, mother, and sisters Diane and Barb on Easter day, 1968.

A Life Lost to Amnesia

Su Meck was just 22 in 1988 when a ceiling fan fell on her head, wiping away her memory and personality. She began her second life in a house she didn't know, with a family she didn't recognize

BY SU MECK WITH DANIEL DE VISÉ

After being in the hospital for only three weeks, I was released to go home. That in itself was a small miracle, because my husband, Jim, was initially told that with injuries such as mine, it wasn't unusual for people to stay hospitalized for eight months, maybe longer. But medically speaking, my MRI scans did not show the doctors any kind of persistent or residual damage to my brain. So in their opinion, I was all better. In the words and spirit of those evangelical preachers, "I was healed!" The rehabilitation staff told Jim, "Our goal is to get someone who is 5 to 15 percent functional to 20 to 30 percent." Jim was told that I was quite possibly at 70 or 80 percent. I was the valedictorian of head injury patients. The hospital records present my release as if it was a matter of mutual agreement. That is how Jim remembers it. But in hindsight, my discharge seems rather abrupt, certainly considering that three days earlier, a neuropsychologist had described me as moderately to severely impaired in five major cognitive areas.

"I remember Jim kept saying, 'We've got to get her out of the hospital, because they keep dropping her on her head,'" my sister Barb recalls.

My mom: "I do think you should have been in the hospital longer than you were."

Here are a few of my own thoughts about all of this now: Jim was driving everyone crazy at the hospital with his demands. He didn't know what to do with our young sons Benjamin and Patrick, he had to go to work and he had run out of, or used up, all his options for babysitting. I think I was somehow "fast-tracked" out of the hospital, either because of Jim's behavior or our medical insurance coverage. All of a sudden, people started writing in my chart that my problem was most likely something psychological rather than physical, and I was shown the door.

To this day Barb tells me, "You were not ready. You should have gone to a rehab facility, or you should have gone home with a crew of therapists; someone to help you with speech, a therapist to help with gross motor skills, and an occupational therapist to help with fine-motor tasks. You couldn't write. Walking and moving around was hard for you. You couldn't even use your left side, and you were left-handed!"

Let's think about this for a second, shall we? And part of this will just be me speculating, of course. Did I know who I was? After three weeks in the hospital? I probably knew my name was Su Meck. Did I know Jim, Benjamin, and Patrick? Did I understand husband? Marriage? Son? Brother? Mother? Father? My guess is no, I didn't. I probably didn't have a clue as to how to take care of myself, let alone two very young boys. Was leaving the hospital really a safe, smart, logical next step? Looking back, I don't think it was safe, smart, or logical. And yet, that is exactly what happened.

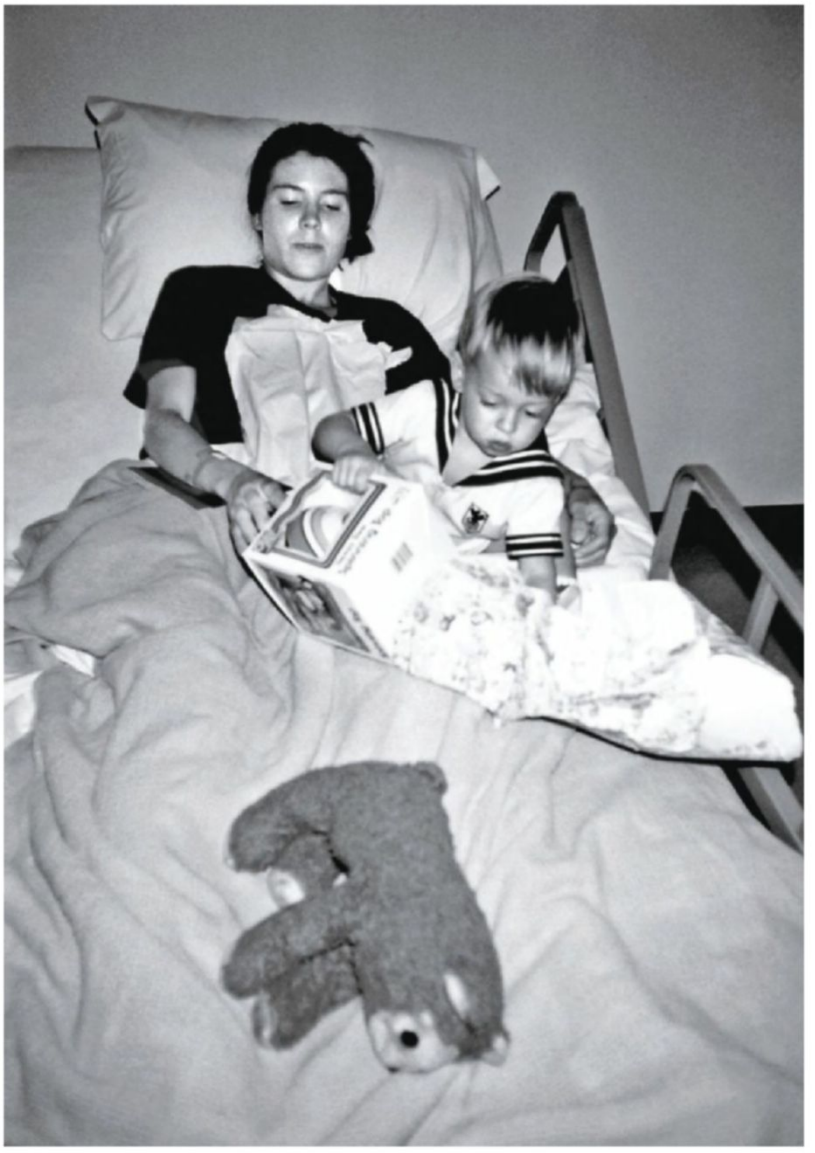
Whatever the reason, I was released and taken to live in a house I did not remember. The 1970s gold-flecked linoleum and shag carpeting, the green scratchy couch, the brown kitchen cupboards, the large backyard surrounded by a privacy fence: None of these things registered with me. Jim remembers

Meck and her husband, Jim, in Texas, in the spring of 1986. At the time, she was pregnant with their first child, Benjamin.

me walking hesitantly down the hallway that led from the family room back to the bedrooms. He recalls me just staring at all of the family photographs that were hanging there. "That's me!" I said, pointing to my image. "And that's me, too!" I recognized myself in the more recent photographs, but I had no recollection of the places where even a single one of the pictures had been taken, or any of the stories behind them. I was not able to identify any of the other people—other friends and family—in the photos. It was sort of like being airbrushed into a life. A real-life Twilight Zone.

I walked into the kitchen and opened every single cupboard and drawer. There was nothing recognizable about any of this stuff. I probably didn't even know what most of the items were called, or what they could possibly be used for. The hospital was all I knew. Everything in this house was unfamiliar, and I can only imagine how bewildering and daunting that unfamiliarity would have been to me. What would it have felt like for me to not know even the names of objects in my own home? But then I think, did I even care?

This is another thing I don't remember: After my accident, when I was still in the hospital, one of the things I was taught how to do was make tuna fish salad. I am sure tuna fish salad was used as a "training food" for food preparation and kitchen safety



Meck in the hospital with her son Benjamin. Her husband brought the stuffed bear in an attempt to trigger her memory. Opposite, a letter Meck wrote to her grandparents six weeks after the accident.

purposes because there are a lot of different steps in preparing tuna fish, as well as a lot of learning how to use kitchen tools. I was taught everything from operating a can opener, to safely using a sharp knife and cutting board, to using a measuring cup, to stirring all the ingredients together with a spoon in a big bowl, and then to finally manipulating another knife to spread the tuna on bread. I was taught how to properly wash and peel fruits and vegetables, and even how to boil an egg in a pot of water on the stove.

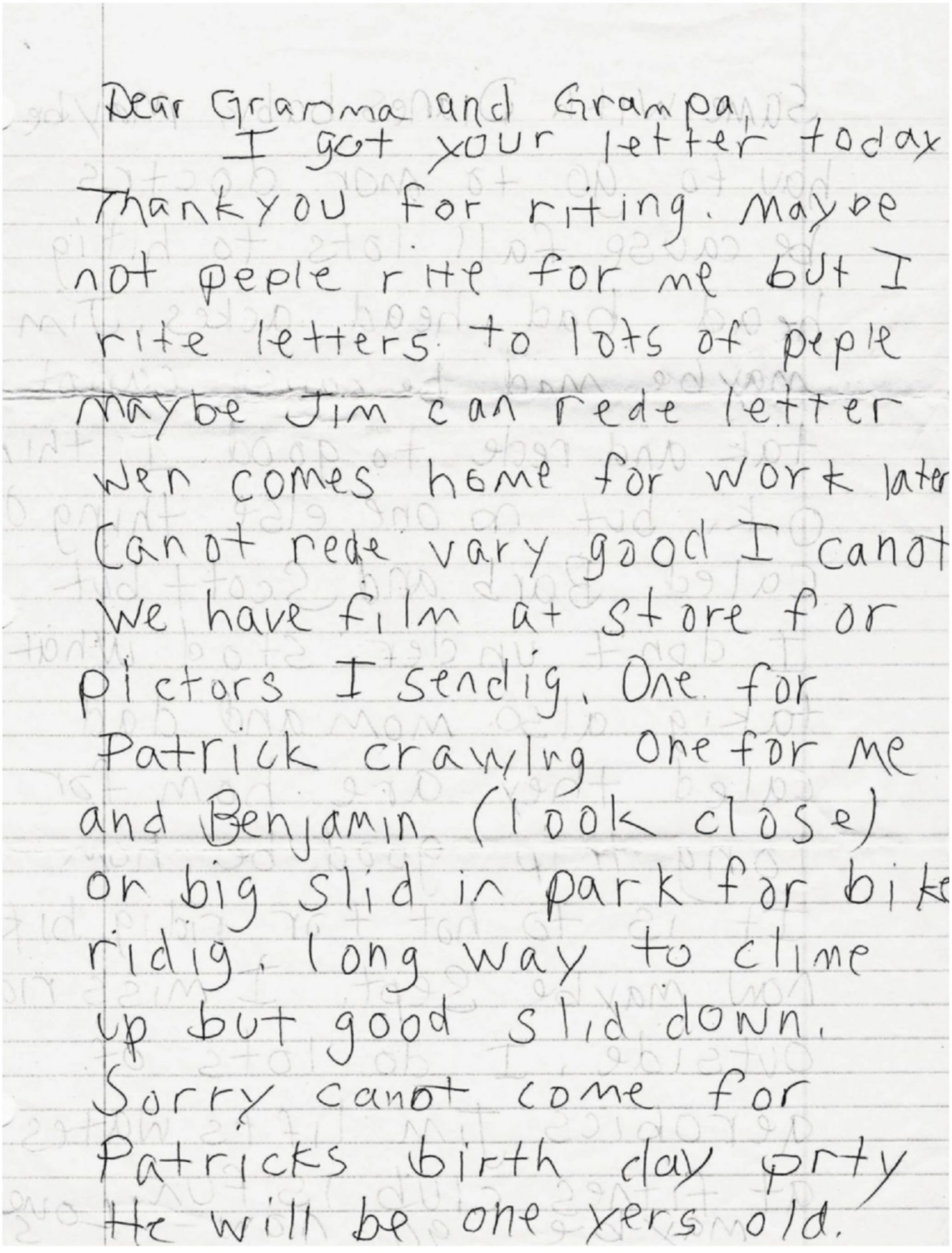
Armed with this vast expanse of knowledge, I was sent home with the expectation that I would be able to feed my family and myself.

And that is exactly what I did. I fed my family tuna fish. Breakfast. Lunch. Dinner. Did anyone complain? I don't know. Did Jim give the boys other stuff to eat? Did he make himself other stuff to eat? Again, I don't know. Did I attempt to cook or prepare anything else? I seriously doubt it. I had been told that "tuna fish equals meal, and meal is what you eat."

I think Jim probably sensed that I needed help, but he was back at work trying to make up for all the time he had missed. Plus, the neurologists kept telling him that there was nothing wrong with me. Jim's parents offered to pay for a live-in nanny to help with the boys, which might relieve some of my stress. Jim asked around and soon hired a woman. And for a few weeks she did, indeed, keep the boys and me alive, keep the house from burning down, and most likely she prevented several major catastrophes. However, she was a devout Christian, and when she came upon Jim's extensive stash of pornography, she told him she could no longer work in our home.

Suddenly Benjamin, Patrick, and I were on our own once again. I would wake up each morning with no memory of what had occurred the previous day. I recognized Jim and the boys simply because I saw them every day, but I would have no recollection of what any of us had done the day before, or what the plan was for that new day. Each day the world beyond my front door was an absolute unknown. Jim says that our family was full of *Lord of the Flies* incidents, in that he never knew exactly what he would come home to after work each day. Would I be there with Benjamin and Patrick? Would we all be gone? Would the boys be playing together in the backyard all by themselves with me nowhere in sight? Would I be there, but have no idea where Benjamin or Patrick were? Would the bathtub be overflowing? Would the oven or stove be on? I am terrified when I think about what that must have been like for the boys and me. I honestly do not know how we all survived those first days, weeks, months, and even years.

My mom wanted desperately to help out somehow, as well as give Jim a break. But my younger brother, Mark, was still living at home and was not



Dear Gramma and Grampa,
I got your letter today
Thankyou for riting. Maybe
not peple rite for me but I
rite letters to lots of peple
maybe Jim can rede letter
wen comes home for work later
Cant rede vary good I cant
we have film at store for
pictors I sendig. One for
Patrick crawlng one for me
and Benjamin (look close)
or big slid in park for bike
ridig. long way to cline
up but good slid down.
Sorry cant come for
Patricks birth day prty
He will be one yers old.

Meck, center, with, from left, her daughter, Kassidy, son Benjamin, husband Jim and son Patrick, in May 2008.

yet driving. Mom felt like she couldn't very well desert him to come to Fort Worth to look after me. Instead it was decided that Jim would drive Benjamin, Patrick, and me to Houston to stay with my parents for a week. My parents now feel incredibly guilty about how little they understood of my new reality. My mom says that all she really knew was that I had this head injury and that I had trouble remembering things. The letters I sent her looked as if a first-grader had written them, "all phonetic misspellings and shaky script on lined paper," but still she and my dad were not overly concerned.

It is highly unlikely that I in fact recognized either of my parents when I climbed out of the car in their driveway. But because Jim had prepared me for this particular reunion, I was able to greet them both with a sort of affection and warmth. Even so, my parents say that they noticed immediately how much I had changed. They had known me as the family troublemaker, loud, defiant, and stubborn. Now my personality was completely different. My dad was surprised at how cooperative and friendly I appeared, nothing like the person I had been even a few months earlier.

Mom thinks it likely that I woke up every morning that week in Houston unsure of where I was or why I was there. I must have been terribly confused to be yet again in a new, unfamiliar place, with unfamiliar people. But Mom thinks I would eventually hear the recognizable sounds of Benjamin and Patrick, and then I would slowly find my bearings, and greet my parents as if nothing was amiss.

My dad remembers something peculiar about that visit. I wouldn't enter the backyard, because of the pool, which absolutely petrified me. He and my mom found that surprising, since I had always been a strong swimmer and loved the water. I had even been a lifeguard as a teenager. Once again, they seemed

not to understand the extent of my impairment. Nobody could comprehend that I was a different person, a new person, just observing and learning stuff as I went along. I seriously doubt I even understood my own fear of my parents' pool.

Because I was so deathly afraid of the pool out back, and wouldn't go near it, we usually spent the hottest part of the day with the boys in the second-floor family game room playing with toys that had belonged to us Miller kids years before. One afternoon I walked over to the piano and sat down. It was the same piano that I had learned to play on as a child. I placed my fingers on the keyboard and began playing Scott Joplin's "The Entertainer." Mom says I played it nearly flawlessly from start to finish. From memory. When I was through, I turned to Mom and asked, "What was that? Where did that come from?" Mom told me that "The Entertainer" was a song that I had learned for a recital as a child. I was not able to ever repeat that performance. It was just gone. A kind of doorway had been opened momentarily, and then just as quickly, it was ruthlessly closed.

All that week, I kept asking for Jim several times a day. But when he finally did arrive the following Saturday afternoon, my mom says I had no idea who he was; in fact, I was afraid of him. Jim says he saw in my eyes instantly that I had once again forgotten him. Of course he was upset by that realization, but what could he do? Apparently, I made my younger brother, Mark, come with us on a walk that evening, because I did not want to be alone with this tall, curly-headed stranger.

A few days after returning home to Fort Worth, Jim sat down with me and taught me how to shave my legs. In fact, he taught me (and retaught me again and again and again) most of what I know about personal grooming. Come to think of it, Jim taught me pretty much everything I know about almost everything. Several weeks (or maybe it was months) later, there was even an awkward conversation about sex. I didn't exactly understand when he tried to explain what it meant to be a "mother" to Benjamin and Patrick. And being a "wife" to Jim was even more beyond my comprehension.

> During the week I visited my parents in Houston, I kept asking for my husband, Jim. But when he finally arrived, I had no idea who he was.

I suppose once upon a time, three years before, Jim and I had fallen in love. After the accident, I had no concept of "love." I knew Jim was there, and I quickly became dependent on him, and later became dependent on the boys, but I didn't really know him very well. I didn't know the most basic things about him, like what he enjoyed doing in his spare time, what his favorite foods were, what genre of books he liked to read, what music he liked to listen to, and hundreds of other little details. I don't think I even really cared so much about any of that stuff, either. I wasn't aware that I was supposed to care.

However, Jim somehow still loved me. He still knew me, or at least the "me" I had been, which still looked like me. He knew everything about me; what I liked to do, eat, read, listen to, as well as every other trivial detail.

Jim remembered our love from before the accident, and he missed it. He tells me that when we were back at Ohio Wesleyan, we "went from being friends to being friends-with-benefits and eventually to a committed and exclusive relationship." He talks about how he and I "would finish each other's sentences." He says we were inseparable and "when we were together, we were simply more." And now that particular Su that Jim had known was gone. I was utterly naive not only sexually, but emotionally as well. I just wasn't ready for such adult feelings, and wouldn't be for a few years. ◻

For a long time after Meck's injury, she suffered both retrograde amnesia and anterograde amnesia, the inability to form new memories. She would wake up "lost" in unfamiliar places and even today does not remember the first 22 years of her life. But in 2014, 26 years after her accident, Meck graduated from Smith College and released her memoir, I Forgot to Remember. *Today, she speaks to survivors of traumatic brain injury and continues to write.*

From the book I Forgot to Remember: A Memoir of Amnesia *by Su Meck with Daniel de Visé. Copyright © 2014 by Susan E. Meck. Reprinted by permission of Simon & Schuster, LLC.*

Memorable Entertainment

Amnesia has been a frequent Hollywood topic since the talkies. Do they get it right?

BY EMILY JOSHU

The theme of memory loss is a Hollywood favorite because it is so relatable, but many movies gloss over the hard science, says Boston neuroscientist Steve Ramirez. "Most people with amnesia aren't Matt Damon going on these super CIA spy scenarios," he adds.

1 / The Bourne Series

(2002–2016)

Former spy Jason Bourne awakes on a boat with amnesia, two bullet holes in his back and one key to his identity—the account number to a safe deposit box. On the upside, Bourne can still fight, shoot a gun and drive. Retaining these motor memories can be typical for amnesiacs, says Ramirez. "You remember how to walk. You remember how to breathe."

2 / Spellbound

(1945)

A new convert to psychoanalysis, producer David O. Selznick wanted to spread the word about therapy and worked with Alfred Hitchcock on this thriller. In it, Ingrid Bergman plays a shrink who helps her colleague and love interest, Gregory Peck, overcome amnesia. Today, some critics dismiss *Spellbound*'s portrayal of therapy as muddled.

3 / Eternal Sunshine of the Spotless Mind

(2004)

In *Eternal Sunshine of the Spotless Mind*, former lovers try to forget their relationship by having their memories erased. What scientists find misleading is the portrayal of memories as localized, says Ramirez: "Many now think memory requires a kind of symphony across the brain for it to materialize, rather than living in this one corner."

4 / Memento

(2000)

After sustaining a head injury in an attack that kills his wife, a man played by Guy Pearce is unable to

4

5

6

7

form new memories. But determined to solve the murder, Pearce tattoos clues on his body. *Memento*'s narrative is told in two storylines, one moving forward in time and one backward, which captures an amnesiac's fractured identity, says Ramirez.

5 / 50 First Dates

(2004)

For many scientists, this rom-com is one of the worst offenders in terms of misrepresenting amnesia. In it, Adam Sandler's character doggedly courts Drew Barrymore's, even though she wakes every morning having forgotten the day before. "Sometimes Hollywood romanticizes [amnesia] to the point of trivializing it. In reality it changes us to our core," says Ramirez.

6 / Finding Nemo

(2003)

When overprotective clown fish Marlin sets out to find his lost son Nemo, he crosses paths with Dory, a blue tang who wants to help but is hampered by her three-second memory. Contrary to popular belief, fish do not have tiny attention spans. But, says Ramirez, Dory's amnesia experience would be accurate for a human. He compares her to Pearce's determined character in *Memento*; neither let their condition deter them from achieving their goals.

7 / Severance

(2022–present)

In Apple TV's psychological thriller series, employees at the mysterious biotech firm Lumon Industries have their personalities surgically split, one half for work ("innies") and one for home ("outies"). Neither side has any memory of the other's life. A 2025 essay in *The Conversation* called the concept "far-fetched," and noted that "the human memory system is far too complex to be entirely split in two—but as *Severance* shows, it's fun to think about the possibilities."

Aging, Memory and Myths

Although the ability to recall memories may begin to decline in your 20s, your fact database peaks as late as 70

BY HALLIE LEVINE

It's easy to panic if you misplace your car keys or forget a person's name. But the truth is, these types of memory lapses are common and can happen to anyone at any age. "Oftentimes, simply being stressed and multitasking can make you forgetful," explains Gary Small, director of the UCLA Longevity Center. The good news is that dementia isn't a normal part of aging—fewer than 10% of people in America over the age of 65 have the disease, according to a 2022 study by Columbia University researchers.

Memory loss, of course, is real, and some types of memory—mainly the ability to think quickly and recall information—start to decline as early as a person's second decade. Episodic memory, which captures the what, where and when of our daily lives (for example, what time a meeting is) can begin to deteriorate starting at about age 30, as do our abilities to process information, hold on to working memory and multitask. But there are ways to work around this. Here, a closer look at some of the myths and realities surrounding aging and memory.

MYTH

It's all downhill after age 20

Although short-term memory peaks in your 20s—and starts to drop at around age 35—crystallized intelligence, or the accumulation of facts and knowledge, peaks in the 60s or as late as 70, according to a Harvard study from 2015. That's very different from what we would have expected to see just 40 years ago, largely because of baby boomers, who are more likely than their parents to be college-educated, with professional white-collar jobs that involve a lot of thinking. And although younger people may be able to recall things more quickly, older people have an advantage because they're sometimes able to take shortcuts. "The older you are, the more likely you are to draw on past experiences or wide social networks to solve a problem," says Small.

MYTH

Supplements can help reduce memory loss

Supplements are unlikely to help, period, says Stephen Rao of the Cleveland Clinic Lou Ruvo Center for Brain Health. Consider fish oil, often touted as a memory aide. A 2012 review by the Cochrane Library, a network of health researchers, looked at studies of the use of fish-oil supplements in cognitively healthy older people and saw no improvement. Similarly, a study published in the medical journal *The Lancet Neurology* of almost 3,000 adults over age 70 with memory complaints found that the herb ginkgo biloba didn't reduce rates of developing Alzheimer's compared with those who took a placebo. DHEA supplements seem to fall into the same category. DHEA is a hormone produced by the adrenal glands, and DHEA supplements—often made from yams or soy—have been touted as a new fountain of youth. A Cochrane review of five clinical trials, however, found no proof that the supplements were effective.

What does work: A Mediterranean-style diet—loaded with fruits, vegetables, potatoes, olive oil, fish, legumes and whole grains—was linked to a 30% to 35% decrease in risk of cognitive impairment in adults over 50 (with an average age of roughly 68),

according to a University of California, San Francisco, study.

REALITY

Other health conditions raise risk of dementia

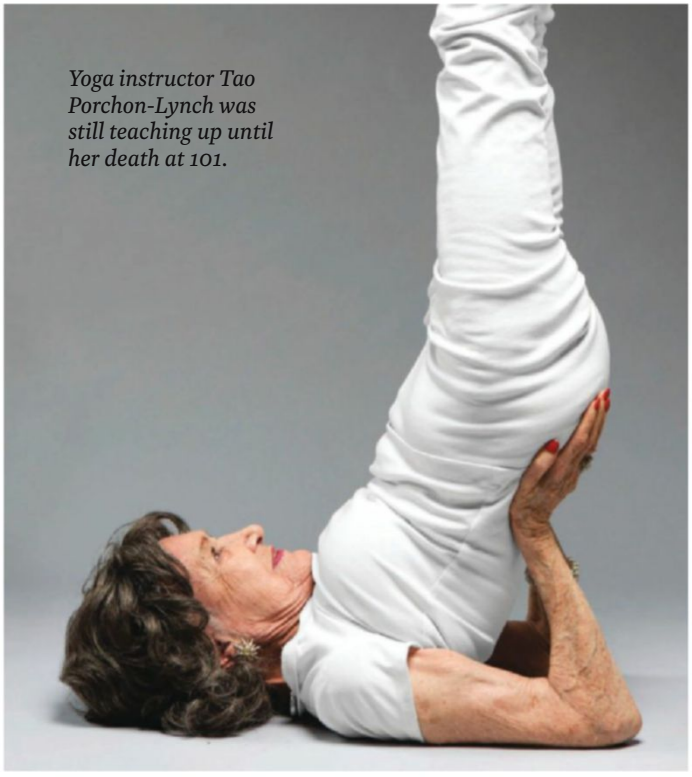
High blood pressure, especially in middle age, is associated with a higher risk of dementia later in life, according to the American Heart Association. The main reason for this is that untreated hypertension narrows and blocks arteries everywhere, including your brain. What's more, researchers have found that cholesterol triggers the formation of toxic clusters of amyloid-beta protein, a key player in the development of Alzheimer's disease. Another condition, atrial fibrillation, or AFib, which is present in about 9% of people over the age of 65, has also been linked to dementia. If you have any of these conditions, it's crucial to get them under control. People with AFib who take blood-thinning medications such as warfarin cut their risk of dementia by nearly half, according to a 2018 study in the *European Heart Journal*.

It is equally important to get anxiety or depression diagnosed and treated. Middle-aged individuals who reported moderate to severe anxiety have been shown to be more likely to develop dementia later in life. "We know that anxiety is associated with higher stress-hormone levels, and, in fact, human studies have found that if you inject someone with a stress hormone like cortisol, it causes temporary memory impairment," says Small.

REALITY

Exercise can boost memory

"It's the most important thing you can do to keep your memory sharp and reduce risk of dementia as you age," stresses Stephen Rao of the Cleveland Clinic. Rao is currently doing research among people who have an APOE4 allele, which increases risk of later developing Alzheimer's. In comparing the MRIs of the brains of sedentary people and people who exercise at least three times a week, he's found that the hippocampus in the sedentary group decreased over 18 months, while the active individuals' stayed the same. Another study, from 2016, found that the more active older adults were, the larger their hippocampus. It's important not to just exercise regularly but to limit sitting as well, adds Small, who found that adults between 45 and 75 who sat at least three hours a day had substantial thinning of the part of the brain responsible for the formation of new memories. "This thinning is usually a precursor to dementia," notes Small.

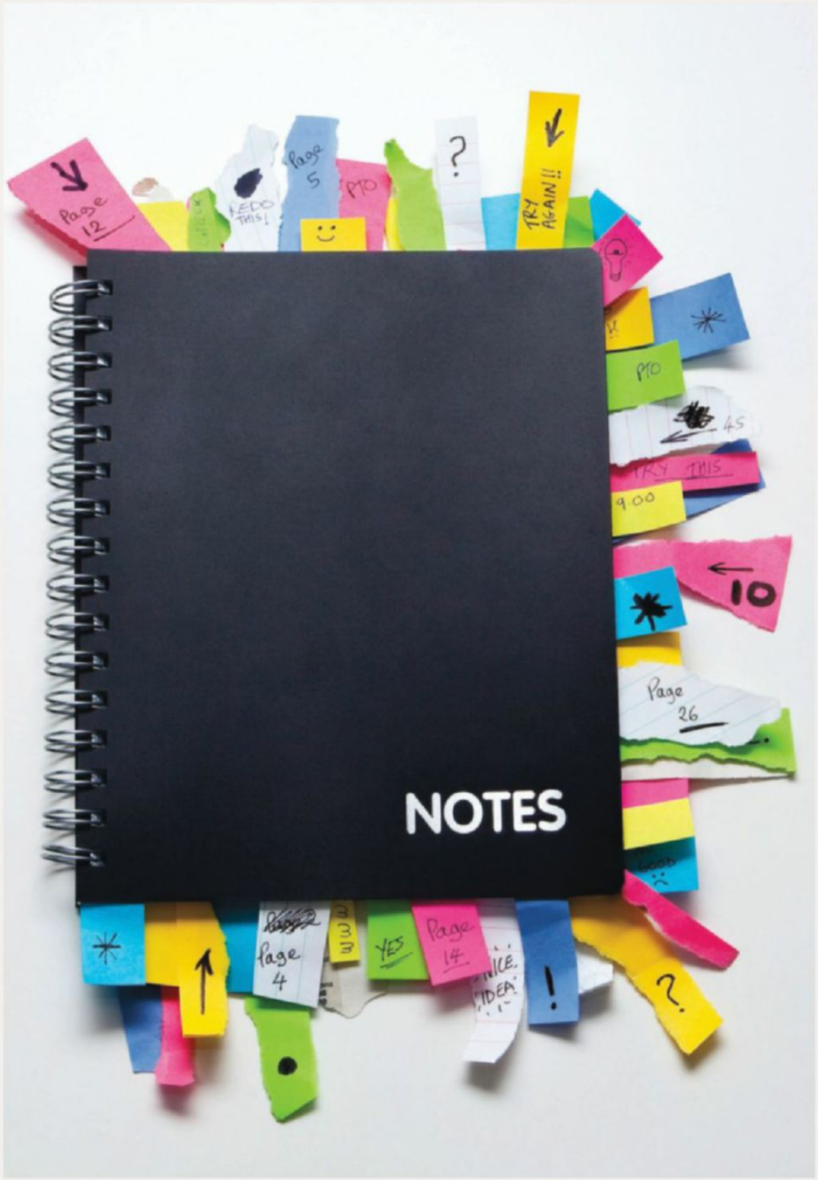


Yoga instructor Tao Porchon-Lynch was still teaching up until her death at 101.

MYTH

"Brain training" can help preserve memory

You've probably heard of computerized "brain training" games touted to help older adults stave off cognitive impairment. But a January 2018 article in the *Journal of the American Geriatrics Society* was skeptical. "The problem with brain training is that they only work for the activity you're being specifically trained for—you may be able to recall your shopping list more easily, but it won't help you remember how to get to the supermarket," explains Small. Instead, he advises learning a new language, taking a class or even just reading the newspaper. People who regularly participate in intellectual activities have a significantly lower risk of dementia, according to a Chinese study published in *JAMA Psychiatry* in May 2018. Or become a do-gooder: Seniors who volunteer regularly have lower rates of dementia, according to a study published in 2017 in *PLOS One*. □



Why Anxious People May Have Better Recall

But at the same time, their memories may be negatively biased if they've had a bad day

BY AMANDA MACMILLAN

You spaced on the lunch meeting you said you'd attend, or you forgot a promise you made to a friend or that the glasses you are looking for are on the top of your head. Minor memory lapses strike us all from time to time. But if your brain seems increasingly unable to hold on to new information, stress may be to blame.

"There's a lot of evidence to suggest chronic stress can lead to memory impairments," says Jason Radley, an associate professor of brain sciences at the University of Iowa. Radley's research has shown that high or prolonged spikes in the stress hormone cortisol may "prune" the synapses in your brain's prefrontal cortex and hippocampus, which are essential for certain brain functions, including memory. "Stress levels naturally elevate through the process of aging," Radley says. For those who suffer from chronic stress, it seems the cumulative exposure to cortisol over a person's life span may actually erode cognitive function.

In an age when people are expected to multitask at work and in their downtime, there are likely some predictable consequences. Behaviors such as bouncing between email and texts or talking on the phone while trying to cook dinner can disrupt your brain's ability to store new memories, warns David Meyer, a professor of mathematical psychology and cognitive science at the University of Michigan who has studied the impacts of multitasking on memory.

"When you're multitasking, that's interfering with processes that normally would be devoted 100% to doing the mental work that moves information from short-term memory into long-term memory," Meyer explains.

He mentions a well-known experiment during which researchers observed the brain activity of people who were trying to learn new information while multitasking. Compared with a group that was focused solely on learning the new info, the multitaskers had disruptions in the parts of their brain that are used for learning and memory consolidation. On a follow-up test, the multitaskers had higher error rates than their single-focus counterparts, Meyer says.

Your brain needs small breaks after a task in order to lock away new memories. If you're replying to emails while participating in a conference call or chatting with a colleague, Meyer says, your over-tasked mind just won't have the chance to store the new information it's collecting.

Enraptured fans at a Taylor Swift concert in Vancouver in December 2024. Their memories of the evening might be vague.

Swiftly Forgotten

Why it can be hard to remember much about once-in-a-lifetime experiences

BY ANGELA HAUPT

THREE DAYS AFTER JENNA TOCATLIAN saw Taylor Swift perform at Gillette Stadium, in Massachusetts, in May 2023, she was still on cloud nine. But something felt weird when she tried to relive the memories: In her mind, where vivid specifics of the concert should have been playing on loop, there was just a blank space.

"Post-concert amnesia is real," said Tocatlian, who lives in New York. She got to hear her top choice for one of Swift's nightly "surprise songs" ("Better Man"), and the experience still felt surreal. "If I didn't have the five-minute video that my friend kindly took of me jamming to it, I probably would have told everyone that it didn't happen," she said. During the hour-long wait to exit the stadium, she started relistening to the set list, asking her friends, "Did she really play that? How much of it did she play?" Tocatlian chalked it up to sensory overload—and the fact that she had been dreaming about the big night for so long, it was difficult to grasp it was really happening. "It's hard to put together what you actually witness," she said. "You're having all these emotions while your favorite

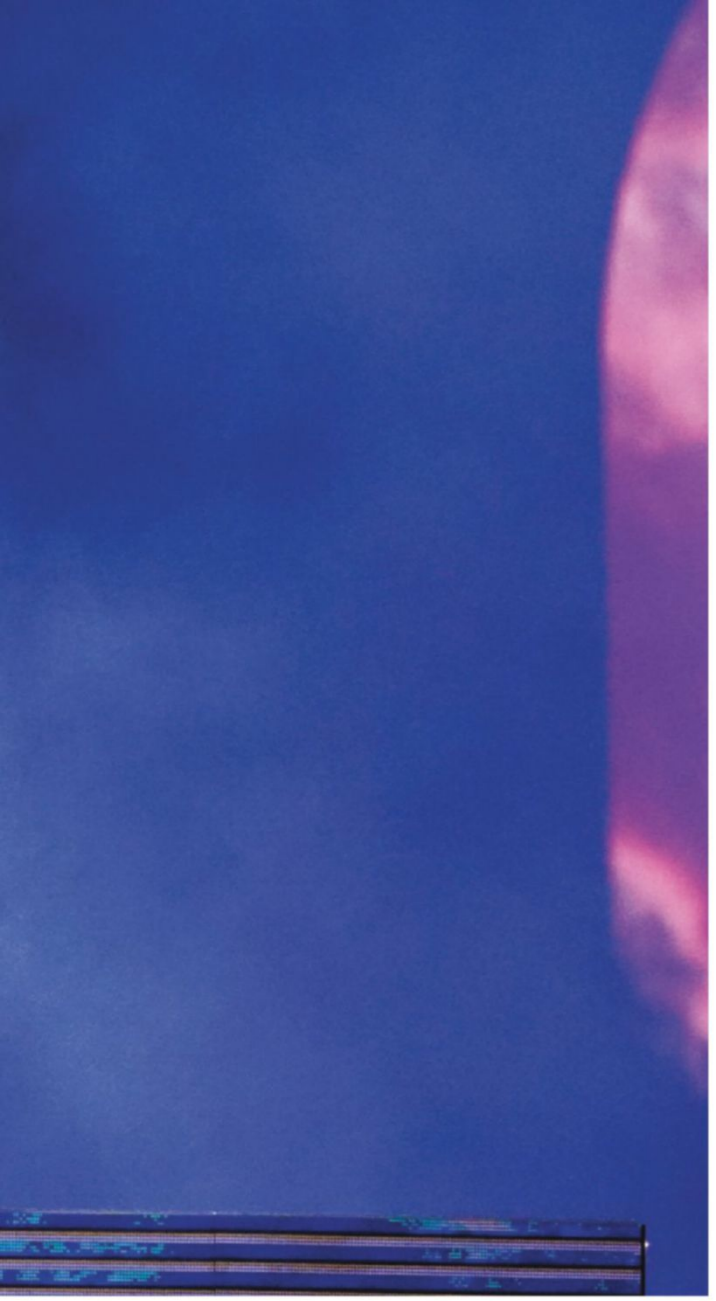
Like many of life's biggest events, a Taylor Swift concert can cause the brain's neurons associated with memory to misfire, clouding the recollection of the experience.

songs are playing, and you're like, 'Wow, where am I?'"

Hundreds of thousands of people packed stadiums across the United States to watch Swift's hugely popular, three-hour Eras tour. Many later took to social-media platforms like Reddit to describe their inability to recall small details or even large parts of the show. One person wrote that they had waited six months for the concert—and after it ended their brain tried to convince them they hadn't been there. Another wondered if they had dissociated during it, and described feeling guilty about not leaving with more vivid memories.

That resonates with Nicole Booz, of Gettysburg, Pennsylvania, who attended one of Swift's shows in Philadelphia. Looking back, it feels like "an out-of-body experience, as though it didn't really happen to me," she said a few days later. "Yet I know it did, because my bank account took a $950 hit to cover the ticket."

So what's going on? For starters, people might simply be too excited, explains Ewan McNay, an associate professor in the department of psychology at the State University of New York at Albany. "This is not a concert-specific phenomenon—it can happen any time you're in a highly emotional state," he says. People getting married, for example, often say they can't remember their first dance or if their Aunt Josephine was there. As the body's stress levels increase—in response to exciting or distressing factors—the neurons associated with memory start firing indiscriminately. That makes it "really hard" to form new memories. "If you're slightly on edge, with



a little bit of excitement, you'll actually remember better," McNay says. "But too much excitement pushes you over the edge in terms of memory formation, and you're unable to make memories."

There's a scientific, biological explanation for exactly what happens when you get this excited (which the body sees as a state of stress). It starts pumping out glucose—the brain's favorite molecule for fueling memory, thinking, and learning—from your liver into your bloodstream. Imagine you ran into a bear in the woods, for example: "You want that fuel for your muscles to go and fight the bear or run away from the bear," McNay says, not wasted on something like memory formation. At the same time, your vagal nerves—which regulate internal organ functions—become stimulated. "You're saying, 'Hey, we're really stressed out: We're running away from the bear, or we're watching Taylor Swift.'"

This response causes your amygdala—the part of the brain responsible for emotional processing—to release a neurotransmitter called norepinephrine. It helps tag memories as having high emotional content, enhancing the likelihood that they'll be saved vividly in your mind. But McNay describes the process as an inverted U: A little bit is good, too much is bad, he says. Plus, if you add caffeine or alcohol to the mix, you'll likely push the curve even further to the right, which means your brain will have a tougher time creating and saving new memories.

It can be surprising and disappointing not to remember everything you think you should about a big event, says Robert Kraft, a professor of cognitive psychology at Otterbein University, in Westerville, Ohio. "We paid a lot of money, we're looking forward to it, and afterward, we want to luxuriate in our memories of the concert," he says. "But our expectations are too high. That's not what memory is—it's not a recorder."

One of the core misconceptions many people have about memory, he says, is that they think of forgetting as a deficiency. In reality, we're simply not designed to remember everything. Situations in which we explicitly focus on remembering are typically limited to stuff like studying for an exam or memorizing a presentation. "We don't set out to remember our lives—we set out to experience them," Kraft says. "Not remembering is actually a tribute to being in the moment and enjoying it."

Still, if you're adamant that you want to better remember an important event, a few strategies can help. The first is a purely mental approach, McNay says: You can try to achieve a "semi-meditative state," perhaps by telling yourself to chill out and be present. Or consider a more physical approach. Your brain monitors your body to figure out what emotional state you're in, he explains. Running away from a bear—or screaming at a concert—tells it that you must be scared. If you commit to standing still, in a relaxed state, on the other hand, you'll send a message to your brain that there's no need to get too excited. That can help encourage memory formation.

Kraft, meanwhile, prefers to remove any pressure from the equation, and to simply focus on having a great time. He's a Swift fan, but like many of us, wasn't able to secure tickets to the Eras tour. If you were in the same boat, take comfort: "I'm sorry that we both aren't going," he said. "But we would have forgotten it anyway." ◻

Memory lapses can result from being distracted, but if they become a pattern then it might be time to consult a doctor.

Is It OK to Forget Things?

Understanding when it's time to take potential memory issues seriously—and when forgetfulness is just a normal part of our busy lives

BY ANGELA HAUPT

If the neurologist Dr. Daniel Lesley sees 10 patients a day, at least half ask him the same question: Are the brain lapses I'm experiencing a normal part of aging? Or should I be worried? "People have an absolute terror of losing their memory and thinking they're losing themselves," says Lesley, who works at Remo Health, a virtual dementia-care company. "They don't know what's normal, what's potentially a sign of something bad, and what's reversible."

Just like every other organ in the body, the brain changes as you get older. Occasional, subtle memory problems—like not remembering where you parked at Costco—are usually no big deal. "Part of normal aging is paying less attention to details and more attention to patterns and dynamics," Lesley says. "It may also become more difficult to access things quickly," like names and certain words.

When sporadic trouble becomes a regular occurrence, however, and other memory issues pop up—like repeating questions or missing appointments—it's time for an evaluation. If you're not sure, ask a spouse, friend, or adult child, suggests Dr. Zaldy S. Tan, director of the memory and healthy aging program at Cedars-Sinai Medical Center. "Have a conversation: 'Have you noticed me repeating anything or asking the same questions? Have you noticed me misplacing things more often?' Because we're not necessarily the best judge of our memory—we don't remember what we forget," he says.

If you decide to make an appointment, it helps to be prepared. Don't just tell your doctor you're getting forgetful, Tan advises; everyone has the occasional senior moment, no matter their age. Log your memory problems in a journal that you take to the visit. That way, "you can be specific about what you're forgetting, how often it happens, and how consequential these things are," he says.

We asked brain health experts to share the signs that it's time to take memory problems seriously.

You have trouble with familiar tasks

Young people often love to multitask, jumping between texting and watching TikTok videos and cooking dinner. That's perfectly doable, because their brains are more plastic—able to easily change and adapt—than those of older folks, and their attention spans tend to be more robust, Tan says. Once

you get to middle age, your capacity for paying attention starts to decrease; plus, you'll probably have a lot more on your plate. That means that one day, when you're making breakfast, you might blank on how to use the toaster oven. "I liken it to having a lot of balls in the air," he says. "I used to be able to juggle five balls, and now I'm only able to juggle four. Guess what? The fifth is the toast, and it's burned."

If you're not multitasking, however, and you suddenly can't remember how to use the washing machine or you forgot to turn off the stove again and it caused a small fire, that's more worrisome. "If you were distracted, I would say, 'Hey, maybe you should pay more attention to what you're doing,'" Tan says. But if that task was your sole focus, and you still ruined the clothing because you washed it in bleach, consider seeking an evaluation.

You miss your usual commitments

If you start dropping the ball on routines or activities you've been doing for a while, something more serious than normal aging could be at play. One of Tan's patients, for example, had picked up her grandchildren from school for years, but suddenly forgot to do so one day. "I think she thought it was a Saturday, not a Friday," he recalls. "In and of itself, it's not like, 'Oh, you have dementia.' But it's certainly something worth noting."

When to worry depends on your baseline, he adds. For some people, forgetting one important commitment might be so out of character that it warrants at least mentioning it to a primary care doctor. Others, however, may realize they were stressed or especially busy when it happened and probably don't need to take it too seriously until it becomes a pattern.

Your personality or mood changes

Several symptoms that aren't memory-related are associated with early Alzheimer's and dementia, including irritability, depression, anxiety, and apathy. "You can see some of these changes beginning years before the diagnosis of dementia is confirmed," says Dr. Gary Small, chair of psychiatry at Hackensack University Medical Center. "People tend to think of this as a cognitive disease, but it's a behavioral disease, too."

You misplace important belongings

If you're walking in the door and talking on the phone—while making a beeline to the fridge for a snack—you might set your keys down and forget exactly where you put them. That's because you were multitasking, Tan says. Misplacing things becomes much more concerning, he adds, if it happens frequently, which goes back to your baseline. Some people are naturally scatterbrained, while others are highly organized, so if they suddenly start losing things, it's a red flag.

Tan always asks patients, Did you forget something important? For example, maybe you left your credit card at a restaurant or your wedding ring at the Pilates studio. Making a habit of misplacing those types of items, which people usually pay close attention to, is more alarming than forgetting where you tossed your keys, he says. Once it happens a few times, or enough that it's causing a real headache in your life, bring it up with your doctor.

You repeat certain questions

Some people are notorious for telling the same stories over and over again—and in those cases, it may be little more than a (sometimes annoying) personality trait. Yet one of the most common complaints Tan hears is that people ask the same questions or repeat the same stories—and the observation usu-

Recognizing your baseline for memory—are you typically detail oriented or frequently forgetful?—will help you understand whether or not your memory issues are normal.

ally comes from a spouse, friend, or adult child. "They'll say, 'My mom keeps repeating the same questions, or telling me the same stories,'" Tan says. He responds by asking what the allegedly forgetful person was doing the first time around. If they were driving and listening to a podcast while asking what time the birthday party at cousin Tom's is the next weekend—and then they asked again a few days later—that's usually no big deal. "But if there's no reason to believe that they just weren't paying attention, then that is of concern," he says. It really comes down to their usual state: If your mom has always been a repeater, that's just her. But if it's a new development, it's worth investigating.

You get lost in familiar places

Following directions is based on visual-spatial memory. As Tan explains, "To get to the grocery store, I know that I have to turn right here and then left there and then there's a drugstore on the corner, and that's when I make a sharp left." When people start getting lost in familiar places, it's usually because their visual-spatial memory is affected. Provided you're paying close attention to where you're driving, "that's a red flag, unless a place has changed a lot," he says.

Your parent developed Alzheimer's at the same age

Age of symptom onset tends to be consistent within families. If your mother developed dementia at 85, and you're occasionally misplacing your keys in your early 60s, you're probably experiencing normal aging, Small says. If she was diagnosed with Alzheimer's at age 62, on the other hand, there's more reason to take your slipups seriously.

Over the years, Small has treated plenty of people with mild cognitive impairment, and many remain relatively stable with interventions like lifestyle changes and medication. "There's a lot of pushback to finding out," he says. "But you can do a lot to keep your mind healthy, and even if you do have a diagnosis of early dementia or mild cognitive impairment, it's not a reason to run away. It's really a reason to be proactive." □

CHAPTER 3

MEMORY NOW

Buffeted by the internet, stress and insomnia, modern life can feel like an endless round of *The Interruption Game*. How is it affecting our recall abilities?

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30
3

The average internet user spends more than seven hours a day online. This connectivity, however, could cause distractions and memory lapses.

The Digital-Era Brain

Critics complain the internet is eroding memory capacity. Supporters say it is opening pathways. Who is right?

BY J.I. BAKER

Revolutionary new technology was promising unprecedented access to information but was also sounding alarms: "This invention will produce forgetfulness in the minds of those who learn to use it, because they will not practice their memory," warned a leading mind of the era. It was 370 B.C., and the speaker was Socrates. The object of his scorn? The dreaded written word.

It was only the beginning of millennia of hand-wringing over technology and memory. In the 1400s, the invention of the printing press prompted concern that monks would become lazy without all that copying to do. In the 18th century, the bogeyman was the newspaper, which French statesman Malesherbes argued isolated readers. Now, several centuries later, the internet is memory's latest alleged enemy, with psychologists, neurobiologists and educators warning that our recall and attention spans are being decimated. The digital us, the concern goes, is distracted and superficial, on the road to intellectual ruin.

But is the internet really corrupting our memories—or will our skeptical experts, like Socrates before them, eventually be proven wrong? After all, the brain's attention system and preferences for novel experiences existed long before the digital age, and our ability to remember is nearly inexhaustible—with about a million gigabytes of mental storage capacity. "Your brain—every brain—is a work in progress," said Michael Merzenich, a neuroscientist and brain-plasticity researcher. "It is 'plastic.' From the day we're born to the day we die, it continuously revises and remodels, improving or slowly declining, as a function of how we use it."

Though we don't know exactly how memories are created or retrieved, we know that neurons talk to one another through synapses, which function sort of like bridges. Information crosses those bridges with the help of chemicals called neurotransmitters. The more neurotransmitters we have and the more frequent their signals, the stronger the connections between neurons become—until the process begins to happen even without the help of neurotransmitters. This leads to the formation of strong memories, but it only works when our brains are actively engaged. In short, the brain is like a muscle—the more you use it, the better it functions.

But our brains don't work well when we're distracted, which we are more than ever these days. According to Microsoft's 2025 Work Trend Index Annual Report, employees are interrupted every two minutes during core work hours by emails, meetings and chat notifications. A survey of college students from 26 states revealed that students spend 20% of their class time texting, playing games and checking social media on digital devices. By constantly interrupting our thought processes, we are interfering with our ability to form both short- and long-term memories, experts say.

Even the fact that many of our online "conversations"—instant messaging on Facebook, for instance—remain unfinished affects our brains' ability to function. This phenomenon is sometimes called "the Waiter Effect," since studies have shown that waiters tend to remember incomplete business with customers better than visits that end normally. "Social interactions are very demanding for the brain," says Erik Fransén, who studies memory at Stockholm's Royal Institute of Technology, "and social media is designed to enable interactions with basically unlimited numbers of people." The mental juggling involved in switching back and forth between platforms and conversations slows down our brains—sometimes for up to half an hour after a switch of topic, Fransén says.

In one study, a group of students said they spent 20% of class time texting, playing games and checking social media.

The contemporary onslaught of information affects our ability to remember too. Though our brains are designed to seek new data, too much of it may be causing this evolutionary instinct to run amok. The compulsion to constantly consume information means we often check Instagram when we should be doing what Fransén calls "memory housekeeping" by giving our brains some downtime. "My greatest concern today concerns our use of social media at time points of the day when our brains need to rest," notes Fransén. "The pauses that once occurred whenever we weren't explicitly focused and active now often get filled with social media."

Another issue: the passive nature of obtaining information online. Trying to actively recall data is a good workout for the brain, but today we google instead—more than 16.4 billion times daily, compared with 3.3 billion times per day in 2012, according to recent estimates. As a result, our attention spans have shrunk from 12 seconds in 2000 to eight seconds—one second less than a goldfish's. This leads to what scientists call digital amnesia: We tend to forget information if we think it can be retrieved from a digital device.

Consider a 2018 study published in the *Journal of Experimental Social Psychology*. Researchers instructed 129 subjects to take self-guided tours of the Stanford Memorial Church on the Stanford University campus. Participants were supposed to take note of details such as "the cruciform shape of the church." Some had camera phones and were told to take pictures so they could post images on Facebook, while others toured without cameras. A week later, the tourers were given a quiz about what they had seen and learned. Those without a camera got seven out of 10 questions right on average, while those who had a camera got six right. "It could just be that we're using these devices, distracting ourselves from the experience, and because of that distraction, we don't remember the thing we're supposed to be paying attention to," Emma Templeton, a Dartmouth psychological researcher who was a co-author of the study, told Vox.

But the internet may be changing merely what we remember, not our capacity to do so, suggests Columbia University psychology professor and researcher Betsy Sparrow. In 2011, Sparrow led a study in which participants were asked to record 40 factoids in a computer ("an ostrich's eye is bigger than its brain," for example). Half of the participants were told the information would be erased, while the other half were told it would be saved. Guess what? The latter group made no effort to recall the information when quizzed on it later, because they knew they could find it on their computers. In the same study, a group was asked to remember both the information and the folders it was stored in. They didn't remember the information, but they remembered how to find the folders. In other words, human memory is not deteriorating

The constant toggling between social media platforms and online conversations is likely causing our brains to slow down for periods of time.

but "adapting to new communications technology," Sparrow says.

In a very practical way, the internet is becoming an external hard drive for our memories, a process known as "cognitive offloading." Traditionally, this role was fulfilled by data banks, libraries and other humans. Your father may never remember birthdays because your mother does, for instance. Some worry that this is having a destructive effect on society, but Sparrow sees an upside. Perhaps, she suggests, the trend will change our approach to learning from a focus on individual facts and memorization to an emphasis on more conceptual thinking—something that is not available on the internet. "I personally have never seen all that much intellectual value in memorizing things," Sparrow says, adding that we haven't lost our ability to do it.

Still other experts say it's too soon to understand how the internet affects our brains. There is no experimental evidence showing that it interferes with our ability to focus, for instance, wrote psychologists Christopher Chabris and Daniel J. Simons in a 2010 *Los Angeles Times* op-ed. And surfing the web exercised the brain more than reading did among computer-savvy older adults in a 2008 study involving 24 participants at the Semel Institute for Neuroscience and Human Behavior at the University of California.

In *How Google Is Changing Your Brain*, Harvard psychologists Daniel M. Wegner and Adrian F. Ward argue that not needing to remember facts might free our minds to focus on more ambitious endeavors and could even help us fix some of the messes we've created. "There may be costs associated with our increased reliance on the internet, but I'd have to imagine that overall the benefits are going to outweigh those costs," observes Benjamin Storm, a psychology professor with the memory lab at the University of California, Santa Cruz. "It seems pretty clear that memory is changing, but is it changing for the better? At this point, we don't know." □

The North German championships of Memory XL, a learning and memory competition.

Battle of the Big Brains

On a lark, an American journalist with average recall decided to train for the USA Memory Championship. His first stop? A cutthroat match in Oxford, England, to observe the world's top "mental athletes"

BY JOSHUA FOER

Having begun to futz around with memory techniques, I didn't yet have any sense of the true scope of the enterprise I was embarking upon. I still thought of my project as a harmlessly casual experiment. All I wanted to know was whether I really could improve my memory, and, if so, by how much. I certainly hadn't seriously considered the challenge by self-help guru and memory impresario Tony Buzan to try to compete in the USA Memory Championship. After all, there were more than three dozen American mental athletes who trained each year for the event. There was no reason to think a journalist who occasionally forgets his own Social Security number could compete against the U.S.'s top memory geeks.

In 2011, when I published *Moonwalking with Einstein*, an account of my year of memory training, Americans had not historically fared well on the international memory circuit. That changed in 2015, when Alex Mullen—who got into mental athletics after reading my book—won the first of three consecutive world championships. But back then, American mentalists were like Jamaicans on the bobsledding circuit—easily the most laid-back folks, and possibly even the most stylish, but on the international stage, behind the curve in both technique and training.

Nobody in North America took memory sport seriously enough to stop drinking three months beforehand, like the eight-time world memory champ, Briton Dominic O'Brien, used to do, and from the looks of it, few competitors engaged in the rigorous physical-training regimen that Buzan recommended. (One of his first, unsolicited pieces of advice to me was to get in shape.)

In those days, U.S. records paled in comparison to the Europeans, and though America had run its memory championship for as long as any country in the world, the best American memorizer had only finished in the top five of the world championship once, in 1999. Perhaps it said something about our national character at the time that America had produced none of the world's best competitive memorizers—that we were not as detail-obsessed as the Germans, as punctilious as the Brits or as driven as the Malaysians. Or maybe, as one European soberly suggested to me, Americans have impoverished memories because we are preoccupied with the

future, while folks on the other side of the Atlantic are more concerned with the past. Whatever the reason, it became clear that if I wanted to learn more about the art of memory— if I wanted to study with the best—I was going to have to go to Europe.

THE GRANDDADDY OF events on the yearlong international memory circuit, the World Memory Championship, was going to be held in Oxford, England, at the end of the summer. I decided I needed to go and called up Ed Cooke, a young grand master from the U.K. I had met at the U.S. competition, to ask if I could crash at his place. Oxford was his home turf—where he'd grown up, gone to college, and now lived with his parents on their country estate located on the town's outskirts, in a 17th-century stone house called the Mill Farm. I arrived a few days early and got the lay of the land.

The favorite to take the title from the reigning world champ, the Brit Ben Pridmore, was Dr. Gunther Karsten, the balding, angular 43-year-old godfather of German memory sport, who had won every German national contest since 1998. Gunther showed up wearing what I learned was his standard uniform: an imposing pair of black earmuffs and metallic sunglasses whose insides had been completely taped over except for two small pinholes. "Extraneous stimuli," as Gunther called them, are the memorizer's bête noire. He also wore a gold belt buckle embossed with his initials, a gold chain over his tight white T-shirt, and black sailor pants. Gunther informed me that in college he was a photo model for Nissan cars, and depending on how you squinted, he looked like the villain in a James Bond movie or an aging figure skater. He was in terrific physical shape, and was, I would soon learn, a fierce competitor. He was carrying around with him a locked, shiny metal suitcase filled with between 20 and 30 decks of playing cards, which he planned to memorize. He wouldn't tell me the exact number for fear it would get back to Ben Pridmore.

Unlike the U.S. championship of the era, which had just five events, none lasting longer than 15 minutes, the World Memory Championships, held at Oxford University, was often referred to as a "mental decathlon." Its 10 events, called "disciplines," spanned three grueling days, and each tested the competitors' memories in a slightly different way. Contestants had to memorize a previously unpublished poem spanning several pages, pages of random words (record: 280 in 15 minutes), lists of binary digits (record: 4,140 in 30 minutes), shuffled decks of playing cards, a list of historical dates, and names and faces. Some disciplines, called "speed events," tested how much the contestants could memorize in five minutes (record: 405 digits). Two marathon disciplines tested how many card decks and random digits they could memorize in an hour (records: 2,080 digits and 27 decks).

The first World Memory Championship was held at the posh Athenaeum Club in London in 1991. "I thought, this is insane," recalled Buzan, who founded the event. "We have crossword championships. We have Scrabble championships. We have chess, bridge, poker, draughts, canasta and Go championships. We have science fair championships. And for the biggest, the most fundamental of all human cognitive processes, memory, there's no championship." He also knew that the idea of a "world memory champion" would be an irresistible draw for the media and a savvy way to promote his books on mind training.

In ancient times, mnemonic aids were crucial to transmitting stories, such as Homer's tale of the Trojan War.

With the help of his friend Raymond Keene, a British chess grand master, Buzan sent out letters to a handful of people who he knew were involved in memory training, and also ran an ad in the *Times*. Seven people showed up, including a psychiatric nurse named Creighton Carvello who had memorized the telephone number of every Smith in the Middlesbrough phone book and another person named Bruce Balmer who had set a record for memorizing 2,000 foreign words in a single day. Several of the competitors wore tuxedoes.

Today, contestants no longer adhere to such a strict dress code, but everything else about the championship has gotten far more serious. What began as a one-day contest has now expanded to fill an entire weekend. Of all the disciplines in a three-day memory decathlon, the first one of the first day, the poem, is the most universally dreaded. For years, Gunther had lobbied to have the event stricken from the contest, but poetry is where memorization began, and to cut it from the championship because a few of the competitors find it difficult would run counter to the competition's underlying premise that memorization is a creative, humanizing endeavor. So every year, a new, previously unpublished poem is commissioned for the world championship. For the first few years of the competition, in the early '90s, the poem was written by British poet laureate Ted Hughes, whom Buzan describes as "an old friend." Since Hughes's death in 1998, the poem has been written by Buzan himself. The 108-line free-verse offering of the year I attended was titled "Miserare," and came from a collection titled "Requiem for Ted." It began:

With most things in the Universe I am happy: Supernovas

The Horse Head Nebula The Crab

The light-years-big clouds That are the Womb of Stars

Briton Andi Bell prepared to memorize a deck of cards during the World Memory Championships.

It went on to list the many things Tony Buzan was happy about, including "God's freezing balls," and ended:

I am not happy That Ted
Is Dead.

The competitors had 15 minutes to memorize as many lines as possible, and then a half hour to write them on a blank sheet of paper. In order to receive full credit for a line, it had to be rendered perfectly, down to each capital letter and punctuation mark. Competitors who failed to underscore just how "not happy" the author was or who mistakenly thought that Ted was "dead" without a capital D would get only half the total points for that line.

The question of how best to memorize a piece of text, or a speech, has vexed mnemonists for millennia. The earliest memory treatises described two types of recollection: *memoria rerum* and *memoria verborum*, memory for things and memory for words. When approaching a text or a speech, one could try to remember the gist, or one could try to remember verbatim.

Cicero preferred the point by point, not word by word, approach, and employing *memoria rerum*. In his dialogue, *De Oratore*, the Roman statesman suggests that an orator delivering a speech should make one image for each major topic he wants to cover, and place each of those images at a locus. Indeed, the word "topic" comes from the Greek word *topos*, or place. (The phrase "in the first place" is a vestige from the art of memory.) Perfect recall of words is something our brains simply aren't very good at, a fact famously illustrated in the congressional Watergate hearings of 1973. In his testimony before the Senate Watergate Investigating Committee, President Richard Nixon's counsel John Dean reported on the contents of dozens of meetings related to the cover-up of the break-in. To the president's chagrin and the committee's delight, Dean was able to repeat verbatim many conversations that had taken place in the Oval Office. His recollections were so detailed and seemingly so precise that reporters took to calling him "the human tape recorder." At the time, it hadn't yet been revealed that there had been an actual tape recorder in the Oval Office recording the conversations that Dean had reconstructed from memory.

While the rest of the country took note of the political implications of those tape recordings, the psychologist Ulric Neisser saw them as a valuable data trove. Neisser compared the transcripts of the recordings with Dean's testimony, and analyzed what Dean's memory got right and wrong. Not only did Dean misremember specific quotes—that is to say, *verborum*—he often didn't properly remember the gist of what had been discussed—*rerum*. But even when his memories were wrong in isolated episodes, notes Neisser, "there is a sense in which he was altogether right." John Dean may have gotten the details wrong, but he got the important stuff right. We all do the same thing when we try to recount conversations, because without special training our memories tend to only pay attention to the big picture.

It makes sense that our brains would work like that. The brain is a costly organ. Though it accounts for only 2% of the body's mass, it uses up a fifth of all the oxygen we breathe, and it's where a quarter of all our glucose gets burned. It has been ruthlessly honed by natural selection to be efficient at the tasks for which it evolved. One might say that the whole point of our nervous system is to develop a sense of what is happening in the present and what will happen in the future, so that we can respond in the best possible way. In the most reductive sense, our brains are fundamentally prediction and planning machines. And to work efficiently, they have to find order in the chaos of possible memories. Much of the disarray that our brains filter out is words, because more often than not, the actual language is just window dressing. What matters is the *res*, the meaning of those words. And that's what our brains are so good at remembering. In real life, it's rare that anyone is asked to recall *ad verbum* outside of congressional depositions and the poetry event at a memory competition.

Though the brain accounts for only 2% of the body's mass, it uses up a fifth of all the oxygen we breathe and burns a quarter of our glucose.

Ultimately, Gunther ended up losing the poetry event to a 15-year-old Austrian, Corinna Draschl, and losing the championship as well. The top prize went to one of his protégés, a quiet and intensely focused 18-year-old Bavarian law student named Clemens Mayer. After botching the spoken numbers and names-and-faces events, Ben Pridmore landed in fourth place overall, lowered the brim of his black hat and walked out the door alone, vowing that he would begin preparing the next day to reclaim his title one year hence.

Ed fared even worse. Of the three dozen competitors, he was one of only 11 who failed to memorize an entire deck of cards in either of the two speed cards trials, which is like a placekicker missing an extra point twice in a row. I ran after him and grabbed him to ask what had happened. "Too much ambition" was all he would say, shaking his head. "I'll see you back at the house." He walked across the Magdalen Bridge to go find a pub where he could watch some cricket and drink Guinness until he'd forgotten his failure.

Standing at the front of the Oxford examination hall, watching the competitors scratch their heads and twiddle their pens as they struggled to recall "Miserare," I felt acutely aware of how odd it was that we'd come to this: that the only place left where the ancient art of memory was being practiced, or at least celebrated, was in this rarefied competition. Here in one of the world's most storied centers of learning were the last vestiges of a glorious Golden Age of Memory.

It is hard not to feel as though a devolution has taken place between that shining era and our own comparatively leaden one. People used to labor to furnish their minds. They invested in the acquisition of memories the same way we invest in the acquisition of things. But today, beyond the Oxford examination hall's oaken doors, the vast majority of us don't trust our memories. We find shortcuts to avoid relying on them. We complain about them endlessly, and see even their smallest lapses as evidence that they're starting to fail us entirely. How did memory, once so essential, end up so marginalized? Why did these techniques disappear? How, I wondered, did our culture end up forgetting how to remember? □

Adapted from Moonwalking with Einstein: The Art and Science of Remembering Everything *by Joshua Foer, published by Penguin Press, an imprint of Penguin Publishing Group, a division of Penguin Random House LLC. Copyright © 2011 by Joshua Foer.*

More than a third of Americans don't get enough sleep, according to the Centers for Disease Control and Prevention.

Why Sleeping on It Is Key to Memory

While you are getting your shut-eye, your brain is deciding which new information to keep and which to discard.

BY PATRICK ROGERS

"To sleep, perchance to dream."

SHAKESPEARE, OF COURSE, WAS describing the ultimate slumber, death, in those words from *Hamlet*, and the phrase, with its soothing cadence, evokes the common notion of sleep as an escape from worldly toil. Yet recent theories of sleep show that the cells of the sleeping brain are not at rest but surprisingly active, conducting nightly rituals such as shrinking to allow fluid to rinse away toxins and auditing levels of hormones, enzymes and proteins. Meanwhile, the brain's metronome, just above the bridge of the nose, is making itself heard far into the organ, synchronizing neural activity in near perfect harmony.

"During the day, the brain is using energy resources to fire neurons," Allan Pack, director of global sleep programs at the Perelman School of Medicine at the University of Pennsylvania, told TIME, but "at night, a switch turns on so the sleeping brain can take advantage of the metabolic downtime to do some cleaning up."

Scientists have long known that the time spent sleeping is ideal for sorting through the torrent of information taken in during waking hours. By making value judgments about what will prove useful later, the brain consolidates bits of information during sleep, the tastes, smells, thoughts and emotions of daily experience, to produce memories that are worth holding on to. Without these sleep-enhanced memories, learning, language, complex motor skills, decision-making and a slew of friends-and-family interactions would be a long, tough slog.

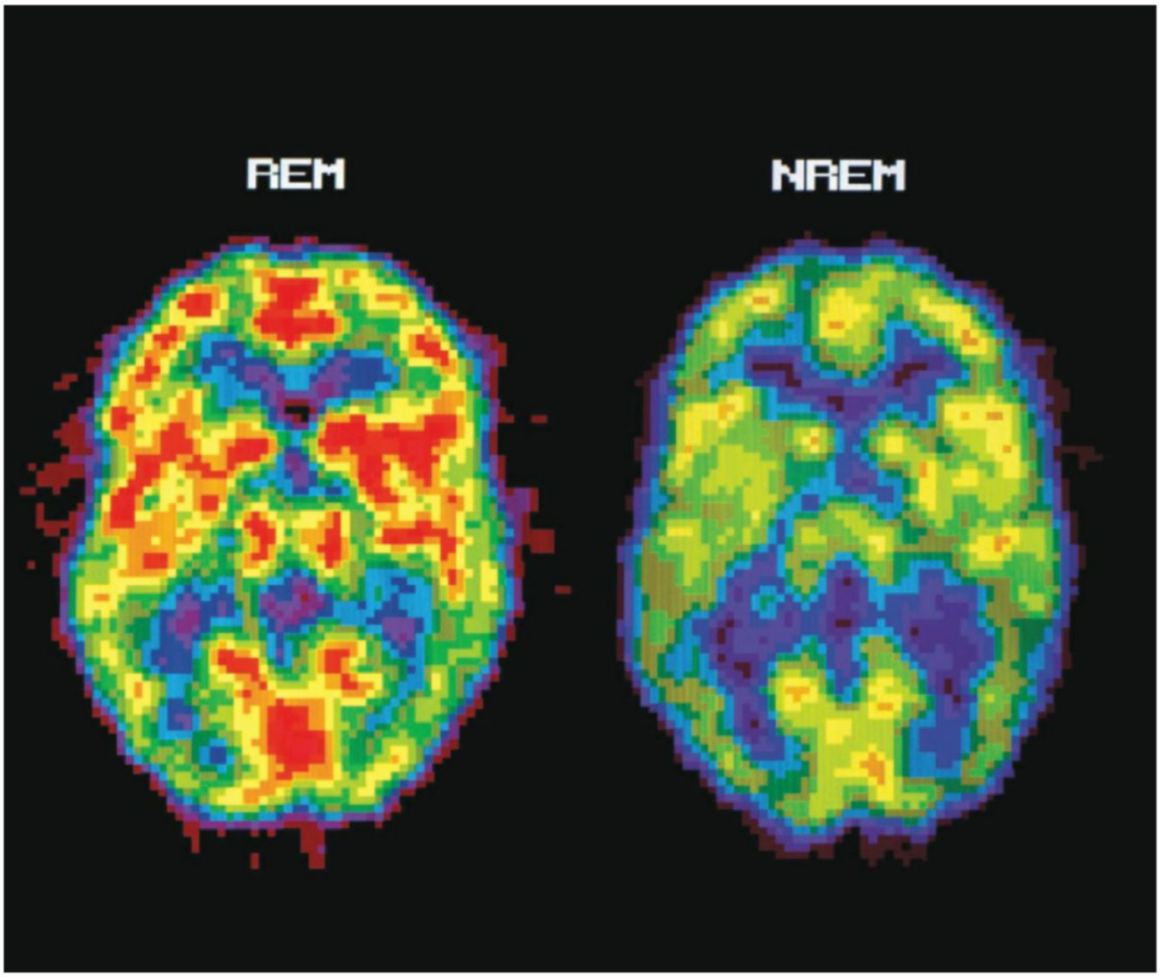
Consider the foundational gestures of social intercourse—greetings. In one study in Boston, a group of people were shown headshots and names of 20 strangers and told they would be asked to identify each subject 12 hours later. "The idea was to recreate the kind of cocktail-party scenario where you meet a lot of people at once and then run into one of them the next day," says researcher Jeanne Duffy, a neuroscientist in the Division of Sleep and Circadian Disorders at Brigham and Women's Hospital, a teaching affiliate of Harvard Medical School.

Only half of the subjects were given a chance to sleep, and when it came time to identify the photos those participants proved to be an average of 12% more accurate at matching a name to a face than the sleepless cohort. They were also more confident of their ability to say hello to the proper person the next day. The theory goes that during the quiet and unperturbed hours of sleep, the memory-making hippocampus, a seahorse-shaped lobe housed deep in the brain, is better able to bind individual bits of data into paired neural connections along which long-term memories are ferried to deep storage in the brain's cortex.

But scientists now believe that a night of rest can do much more than help with simple recall. In his laboratory at the University of California, Berkeley, neuroscientist and psychologist Matthew Walker, author of the 2017 best seller *Why We Sleep: Unlocking the Power of Sleep and Dreams*, has developed an elegant theory that answers one of the key questions in sleep research: Why do we cycle through different modes of sleeping each night? Walker suggests that slow-wave sleep, as well as REM or "dream sleep," have distinctly beneficial impacts on memory formation and processing. They allow us to update our neural circuits at night and efficiently manage the finite storage capacity of the brain.

REM TAKES ITS name from the rapid eye movements that characterize the phase. In a typical sleep cycle, REM is followed by a descent into the deeper unconsciousness of non-REM, or NREM, sleep. Eventually we end up in the state of slow-wave sleep, when brain waves slow to one tenth of typical daytime frequency, before starting the cycle over again. Each cycle lasts about 90 minutes.

There's no consensus as to why we lurch between stages of sleep in a pattern that, on paper, looks like a cross section of a jagged mountain range, and anything but restful. But Walker argues that these convolutions of the mind are steps in the building of resilient memories. In one experiment, Walker and his colleagues exposed a group of volunteers to new information, then monitored their brain waves as they nodded off into naps. As the volunteers entered stage 2 NREM sleep (still a light sleep), the researchers witnessed tiny bursts of electricity called sleep spindles traveling between the hippocampus and the brain's cortex. A transfer of information was taking place: The brain was clearing the shelves of its fragile short-term memory banks while moving the most important information to more stable, long-term storage. The more sleep spindles the volunteers experienced during their naps, the greater the restoration of their learning when they woke up. The result was a thorough weeding out of the



A PET scan of the brain during REM and NREM sleep. Color coding shows red areas as the most active, through to dormant blue.

day's earlier lessons that left plenty of room to take in new information.

Even more surprising were the researchers' findings about REM. They asked volunteers to view 150 disturbing images two times, separated by a period of 12 hours. Half of those who slept in the interim were noticeably less stressed out by the images when they viewed them for the second time versus those who hadn't slept. Researchers monitoring their brain waves found decreased electrical activity in the amygdala, a region of the brain that processes emotions, during their REM sleep, when levels of the stress-inducing chemical norepinephrine also drop. In other words, the brain at rest found ways to calm the emotions that adhered to the photos the day before, making the memory of them more manageable. "We sleep to remember and we sleep to forget," Walker says. "I call it overnight therapy."

Just as sleep can take the sting out of painful memories by allowing us to move beyond them, the opposite may also be true, adds Walker. A lack of REM sleep may condemn us to reliving an old trauma as if it were new. "The more nights you sleep, the more soothing the influence of sleep on that memory," he said.

Indeed, other researchers have recently shown that less than five hours of repose at night can lead to forming false memories, and psychologists in San Francisco have uncovered a connection between learning a physical skill by day and increased activity in the motor cortex, the brain's center for executing movements, during certain stages of sleep.

Perhaps Shakespeare's moony Hamlet sought only oblivion at the end of the day, but the poet's fiendish Macbeth knew what he was talking about when he contemplated sleep after murdering a rival: "balm of hurt minds, great nature's second course, chief nourisher in life's feast." □

Out of Mind

What do we stand to lose—and gain—when we wipe out a memory?

BY DAVID BJERKLIE

A DISTRAUGHT 23-YEAR-OLD WALKS into a clinic and pleads with the receptionist: "I've got to have a memory erased!" Would you approve of such a procedure? Most people's gut reaction would probably be along the lines of, "Well, it depends." If that 23-year-old was crippled by fear because he had been brutally assaulted, for example, or paralyzed by PTSD because she had survived an ambush in which fellow soldiers were captured and executed, then perhaps so. On the other hand, it's easy to imagine scenarios in which erasing a memory would seem unnecessary, misguided or even frivolous.

To be able to erase memory is as unsettling a prospect as it is riveting. No wonder it's been a sci-fi plot staple for at least half a century. But now, it appears, researchers may actually be on the cusp of making memory manipulation a reality. The potential applications understandably are getting a lot of attention, as is the question of whether or not people will want to override their memories. But there are also a range of concerns that should give us pause, cautions Arthur Caplan, a medical ethicist

Survivors of the Bataclan attacks in Paris were evacuated by bus. Some were treated by psychiatrist Alain Brunet, who has been testing the effectiveness of propranolol in dampening traumatic memories.

at New York University's School of Medicine. "I think people are looking at memory alteration in ways that trivialize it. My message is that it should be taken seriously."

A growing body of research suggests that memories are reactivated each time we bring them to mind, not retrieved whole, like we might pull something from a file drawer. The act of memory is an act of reassembly. Although the analogy is imperfect, imagine that at the cellular level, where memories exist as connections and paths, we are refreshing a neuronal GPS using the latest information.

The process is called memory reconsolidation, when a window briefly opens and a memory can be updated with new information. It is during reconsolidation, for example, that the emotionally charged memories triggered by PTSD flashbacks can be softened. The challenge is to trigger the memory—to ask the soldier, for example, to recall the details of the ambush—and to then intervene to diminish the emotional reaction to that specific memory. Think of it as tweaking the GPS to generate a new and less stressful route.

Scientists first learned ways to override a simple memory they intentionally created in mice, using an electric shock every time the animals heard a particular sound. Researchers then explored ways to achieve something similar in human subjects. There is now a range of other experimental interventions aimed at interrupting memory reconsolidation. There are drugs that inhibit certain receptors or the synthesis of certain proteins; there are drugs that lower the levels of the stress hormone cortisol; there are techniques such as electroconvulsive therapy and deep brain stimulation; there are also behavioral approaches, including ones based on neurofeedback techniques or subliminal exposure.

Alain Brunet, head of the National PTSD Research Center at the University of the Sunshine Coast in Australia, uses propranolol, a drug used to treat high blood pressure by blocking the action of the stress hormone epinephrine. It turns out that propranolol also blocks the action of epinephrine in the amygdala, the almond-shaped structure in the brain that plays a critical role in mediating the interaction of emotions and memory. Brunet had been testing propranolol in small trials but had the opportunity to bring the nascent treatment to a larger venue in November 2015, when terrorists killed 130 people in an attack on the Bataclan theater and surrounding

At a neuroimaging center in France, researchers monitor cerebral activity. Opposite, veteran Cliff Drake was cured of PTSD at Brainsake, a biofeedback center in Maryland.

neighborhoods in Paris. "I went to offer my help," says Brunet, who eventually trained 200 clinicians and treated 320 individuals traumatized in the attack, and in the process they learned how they might begin to "create a model of treatment." Propranolol is especially promising, says Brunet, because "it's cheap, it's safe, we know its side effects, we know who we can give it to and who we shouldn't give it to. It's very close to ideal."

Brunet is quick to explain that the treatment does not wipe out memories. That isn't possible yet, nor is that the intent. "We are taking the pathological sting out of the memory." The patient still remembers the event, but in a way that fades with time. "They might still find it sad. But it's like when you think of an old girlfriend, an ex. You can still think about it, but you are no longer in the terrible grip of the memory."

And it isn't just PTSD that Brunet thinks can be effectively treated with propranolol. Many mental states fueled by highly emotional memories could potentially benefit, including depression, substance abuse, certain phobias, anxiety and adjustment disorders, pathological mourning and, yes, even runaway obsession over romantic betrayal. This is not a magic bullet, of course. Just as we now know there isn't a single memory system, we also know there is no single experience of trauma. There are traumatic events that happen once, and traumas such as sexual abuse and domestic violence that happen repeatedly, over the course of years. Trauma can be part of the environment in cases of poverty or racism.

"We know very little about these complicated situations in terms of what goes on in the brain," says New York University researcher Joseph LeDoux, who studies the connection between memory and emotion, particularly fear and anxiety. What we do know, though, is that the consequences of such experiences and environments can lead to PTSD that is more complex in terms of time frame and volume of memories. It is unclear whether trauma of these varieties will ever be amenable to reconsoli-

Vietnam vet Ned Broderick in his Chicago art studio. He was treated with propranolol to deal with war memories.

dation treatment. "Theoretically you could break down complex trauma stimuli into various trigger components individually targeted for intervention," says LeDoux, "and kind of chip away at it until the patient is comfortable in some sense."

The basic question, however, remains. Will people actually want to rewrite their memories, and, if so, under what circumstances? There are good reasons to expect that people would at least want the choice. We love choice. Perhaps too much, as Columbia University researcher Sheena Iyengar points out in her book *The Art of Choosing*: "Choice gives us permission to imagine a better self, and it holds the promise that we can create that self through our own volition." And while "choosing helps us create our lives," we also know that most of us are less than perfectly skillful choosers.

To choose to erase—or even dampen—a memory would be a big decision for most of us. University of California, Irvine, psychologist Elizabeth Loftus and colleagues devised an experiment that aimed to look at the factors that might enter into such a choice. They asked nearly 1,000 study participants (half from New Zealand and half from the U.S.) to read one of two scenarios in which the participant was asked to imagine being either a restaurant manager who was stabbed and robbed of money in a vicious assault, or a soldier on a peacekeeping mission in Afghanistan who was stabbed and robbed of supplies in a vicious assault. With that exception,

the wording of the scenarios was the same. Participants also read a statement about the risk of developing PTSD. Some subjects read that scientific studies had established the risk to be 4%, some read that the risk was 40%, and still others read a statement in which the risk was not quantified.

Subjects were then asked if they felt they should be given the choice to take a memory-dampening drug. It turned out that just over half of the subjects believed in having the choice to take the drug and only about a fifth said they would actually take it. The researchers were surprised the numbers were so low. Perhaps people are just generally optimistic that they could surmount such a trauma? Or maybe the trauma wasn't dire enough? Or perhaps they were uncomfortable about tinkering with memory?

WHILE IT'S IMPOSSIBLE to say if and when these drugs and techniques will be widely available, we have a pretty good idea of what the debate over their use will look like. "The first concern will be the risk of intervening in the brain when we don't fully understand how memories are formed," says Arthur Caplan, the medical ethicist at NYU. "The second will be issues of access and cost." Which, in turn, will lead to issues of fairness and geography. "People may think it's great to have memory therapy in the U.S. and Europe, but what about the people in the Democratic Republic of Congo who have been through mass rape and barbaric civil war? Do we care? Does it matter? Will we pay for it?"

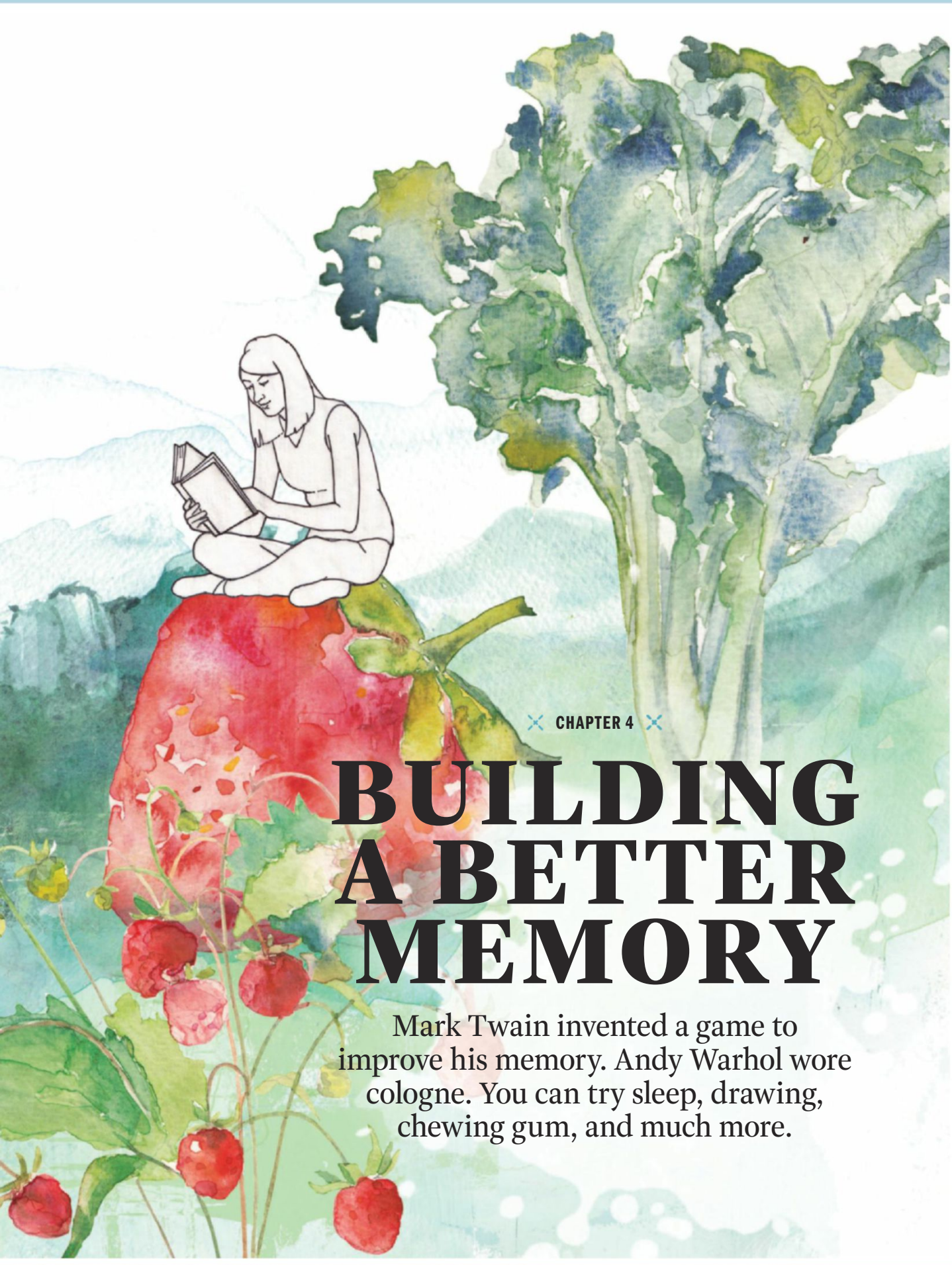
It is the more abstract concerns, however, that generate the most attention. LeDoux remembers the pushback to a key paper from his lab that, when it was published in 2000, demonstrated how a drug could seemingly eliminate a memory in rats. "George Bush's bioethics panel put out a statement basically saying that memory is sacrosanct, that you can't be messing with memory in people," says LeDoux. "But every human interaction involves messing with memory. Every therapeutic exchange also does." The alarm raised by ethicists was triggered by the specter of people blithely popping pills to forget their traumas. Isn't trauma an important part of who we are and how we grow? they asked. But what may have appeared like mindwipe in experiments with rats, however, is in reality far more subtle in humans.

Although current therapies for interrupting reconsolidation can change only the emotional magnitude of memories, not their factual content, researchers acknowledge that, yes, someday memory elimination might be possible. Which makes it easy—and perhaps necessary—to project our concerns into worst-case scenarios. We need to recognize, says Caplan, "that this isn't just about things that give us nightmares. Eliminating memory might be something the individual wants but won't be so great for society. Memory plays a crucial role in our legal system. Do we say you can wipe out that memory, but not until we bring it to trial? Memory is part of how we hold people accountable." And even if our ability to modify memories is confined to smoothing their jagged emotional edges, Caplan is still concerned. "Anger, fury, indignation, crying, remorse—all of this stuff counts in court." It also counts in our lives. What happens to our personal narrative, our sense of self, if we strip out the emotion attached to the bad stuff?

"Eliminating memory might be something the individual wants but won't be so great for society. Memory plays a crucial role in our legal system."

There will undoubtedly be trade-offs, for individuals as well as societies. But with any of these concerns, says LeDoux, it's a mistake to consider—let alone dismiss—the concept as a single thing. What we have to do, he says, is ask, "What happens in this kind of situation with this kind of patient, and what exactly are we trying to treat or change, and is that possible?"

The machinery of memory we rely on has evolved because it is efficient. Walt Whitman's "I contain multitudes" is an apt description of our interlocking memories and the systems in which they reside. Rewriting our memories, forging and forgetting them, even intentionally, is something we do on our own. That's not to shrug our shoulders about the prospect of pills or procedures to enhance those processes, but rather to try to address and more fully understand what it is that we lose—and gain—when we change a memory. ◻



CHAPTER 4

BUILDING A BETTER MEMORY

Mark Twain invented a game to improve his memory. Andy Warhol wore cologne. You can try sleep, drawing, chewing gum, and much more.

Train Your Brain

Understanding how recall works is the job of neuroscience, but there are plenty of tricks, foods and exercises that may help to protect your memory from decline

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One of our greatest fears is losing our memory capacity to a disease such as Alzheimer's, but there are ways to not only sharpen the recall we have but also potentially ward off the illness. It starts, perhaps unsurprisingly, with diet. Some research suggests foods rich in vitamin E and leafy greens could have a role in lowering the risk of the disease. To preserve memory, exercise is a no-brainer, but there are surprising strategies as well, including drawing information rather than writing down words, chewing gum and associating quirky images with material to be remembered.

HELLO

Robert

DARK GREEN LEAFY VEGETABLES

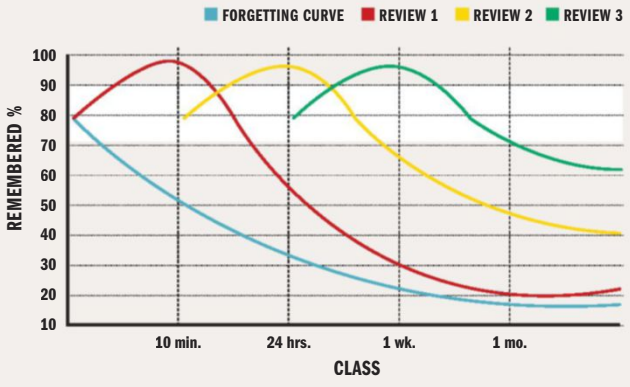
Kale, collard greens, spinach and broccoli are good sources of vitamin E and folate. Exactly how folate may protect the brain is unclear, but it may do so by lowering levels of the amino acid homocysteine, which has been linked to an increased risk for heart disease and may trigger the death of nerve cells in the brain.

When we are between the ages of 30 and 34, we can identify about 83% of faces, a percentage that slides to 75% at age 70.

—DARTMOUTH COLLEGE AND HARVARD UNIVERSITY STUDY

The Unforgiving Curve of Forgetting

The forgetting curve, which shows how quickly we forget information, is steepest in the first 24 hours after we learn something. Just how much then evaporates into thin air varies from person to person, but unless you review the material, you'll forget most of the new information after the first day. The rest will slip away gradually.



Six-Minute Test

In an episode of Friends, *the individual members of the group try to name all 50 U.S. states in six minutes. Can you do it? (For the record, Joey reaches 56 but then concedes South Oregon isn't a state, dropping his total to 55.)*

Drawing on Experience

Memory may be imperfect, but a recent study suggests an unusual strategy

As long ago as 1973, investigators were exploring the memory-boosting advantage of dual-coding—how thinking about an object and drawing a picture of it can make us remember it better. Research showed that the strategy worked, but the studies were flawed, failing to account for important questions, such as if writing a word in a time-consuming way, like calligraphy, would boost recall.

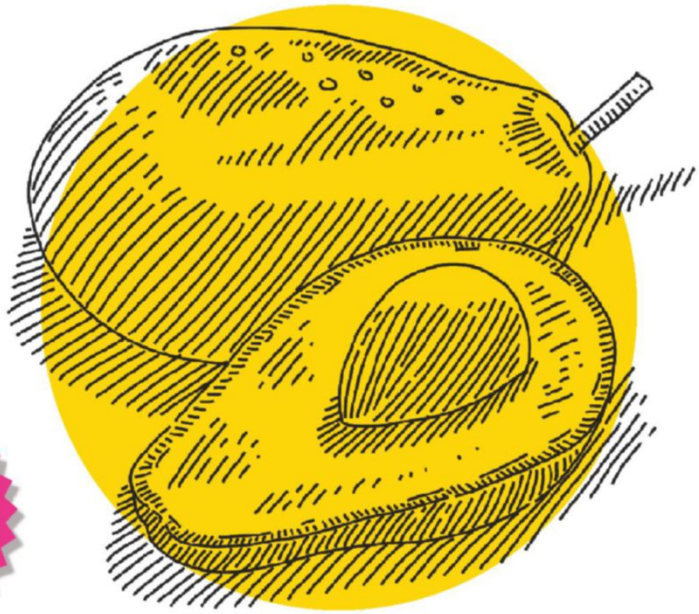
Enter psychologist Jeffrey D. Wammes. He ran a series of trials built around some easy-to-draw objects, such as a balloon or a fork. After viewing the items flashed on a screen, participants were told to either draw the item or write its name. They then performed an unrelated task (identifying tones) to allow the memories to either consolidate or vanish. In one trial, subjects were given four seconds to write down as many of the objects as they could, but in the rest they got 40 seconds, along with a variety of instructions.

No matter how many variations of the test the researchers ran, drawing beat every other option, every time. Just why isn't clear. One theory had been that drawing requires a deeper level of processing. But in one trial, the subjects were required to list the characteristics of an object, which went pretty deep too. Another theory had been that drawing simply takes longer, but the four-second trial appeared to debunk that. For now, Wammes only concludes that drawing encourages the integration of various aspects of a memory trace.

List Your Top 10 Memories

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

Odds are, most will be from your teens or 20s, when we try big things for the first time.



AVOCADOS

This creamy treat is a rich source of the antioxidant vitamin E, which some researchers suggest is associated with a lower risk of developing Alzheimer's.

"If I've been wearing one perfume for three months, I force myself to give it up . . . so whenever I smell it again it will always remind me of those three months."

—ANDY WARHOL

Fetal Recall

Experiments have shown that fetuses as young as 30 weeks can remember what they hear, supporting stories by mothers that their newborns calm down at certain sounds. Scientists even think that prenatal memory is key in an infant developing an attachment to his or her mother. One study looked at babies whose mothers had watched a popular soap opera while pregnant and found that the infants calmed down when the show's theme music played.

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Need to Memorize a Long Number?

Memory champ Chester Santos suggests breaking it into clusters of three and associating a word with each group. For the number above, it could be: 689 (lightbulb); 904 (tissue); 897 (camera); 521 (octopus). Think of a tiny lightbulb. You wrap it in tissue; Madonna appears and takes a picture. She trips, drops the camera in the ocean, and an octopus grabs it. Read the sentences a few times; recite the words in parentheses. When you see "lightbulb," you'll think of 689; "tissue" will prompt 904, and so on.

Visualize. Visualize. Visualize.

Not convinced that visualization helps your memory? A Harvard study found that people who visualized playing the piano turned on the same part of the brain as those who actually practiced the piano. The finding suggests that mentally practicing, say, a golf swing could lead to mastery with less physical practice, and more profoundly, that mental training changes the physical structure of the brain.

Memory Power: The Best Time to Exercise

Move it or lose it.

That's the message from a study published in the journal *Current Biology*, in which researchers found that people who exercised four hours after a memory task retained information better than people who exercised immediately after or who did not work out at all.

Seventy-two subjects participated in a picture-location task for about 40 minutes. They were either assigned 35 minutes of exercise right away, exercise four hours later or no exercise. Two days later, the people returned to see what they remembered and to have their brains scanned. Those who exercised hours later had better recall and more clear activation in the areas of their brain associated with memory retrieval. Although the study was too small to prove that four hours is the magic number linking exercise and remembering, you might consider a workout as part of an overall memory strategy.

FISH

Salmon, mackerel, tuna and other fish are rich in heart-healthy omega-3 fatty acids, including docosahexaenoic acid (DHA), which studies have indicated may help improve cognitive function. Plus, if you are eating fish more often, that means eating less red meat and other forms of protein that are high in artery-clogging saturated fats.

PEANUTS AND PEANUT BUTTER

Peanuts and peanut butter are both high in fat, but it tends to be the healthy kind; plus, they are packed with vitamin E and may help keep the brain healthy and functioning properly. Other good choices are almonds and hazelnuts. "There has been some very good research that diets that are high in healthy fats, low in saturated fat and trans fats, and rich in whole grains, green leafy vegetables and nuts are good for the brain," says Maria C. Carrillo, the chief science officer at the Chicago-based Alzheimer's Association.

"I hope when I get old I don't sit around thinking about it / But I probably will / Yeah, just sitting back trying to recapture . . . Boring stories of glory days."

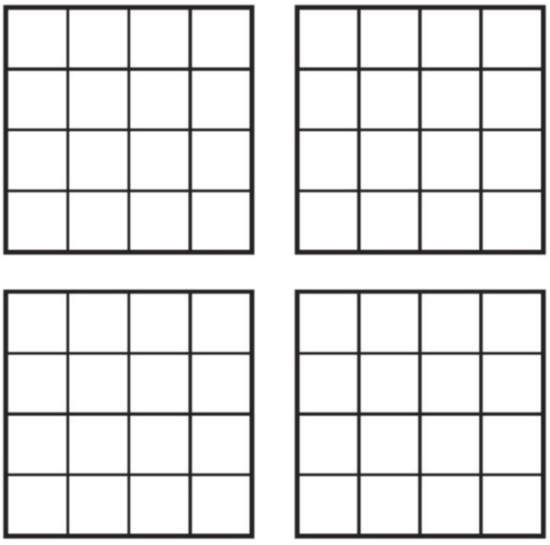
—BRUCE SPRINGSTEEN

The Binge Factor

TV binge-watchers forget contents more quickly than people who watch an episode a week, according to a study from Australia. Right after watching a show, bingers scored high on a contents quiz, but after 140 days, they scored lower than viewers who watched the same show weekly. Bingers also said they enjoyed the show less than the once-a-weekers.

Lock in the Grid

Test your visual short-term memory. Make a copy of the images below and set it aside. Then color in one or two of the squares in each grid. Close the magazine and try to replicate the pattern on your copy. See if you can improve your score.



Ace the Cocktail Party Circuit

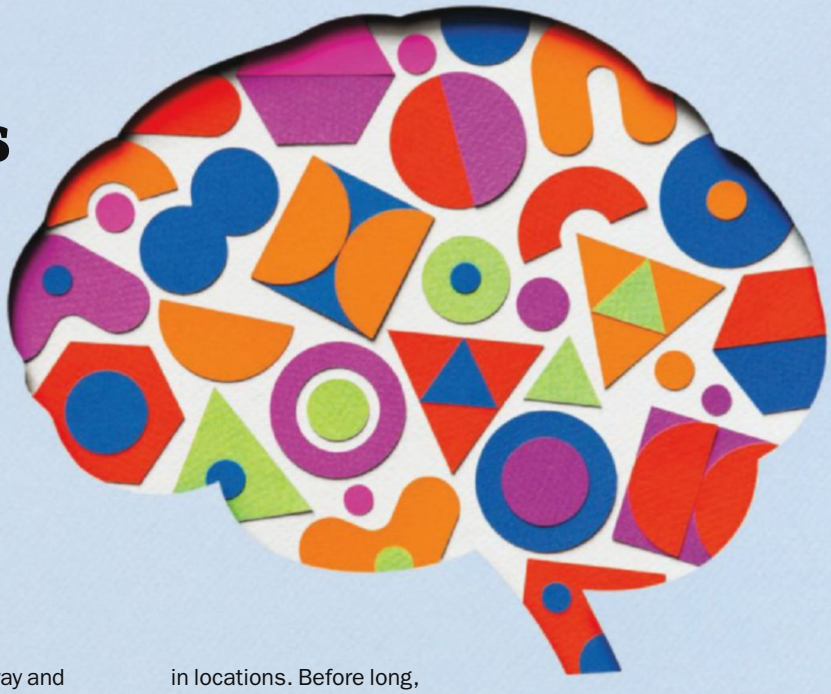
When you meet someone, pay attention to their name and repeat it in conversation. *Hello, Robert. Nice to meet you, Robert. Where are you from, Robert?* Come up with a mental association, like a famous person with the same name—say, Robert Downey Jr. Or picture a hapless bank robber covered in burrs. In your mind, ask what the person's name is again. And then one more time.

WHOLE GRAINS

Fiber-rich whole grains are an integral part of the Mediterranean diet, which is also loaded with fruits, vegetables, nuts and seeds, olive oil and wine. Research out of Columbia University Medical Center in New York City shows that this diet may be linked to lower risk of the mild cognitive impairment that can progress to Alzheimer's disease. "We don't eat foods or nutrients in isolation; we eat in combination with other foods, so there is value in dietary patterns," says Nikolaos Scarmeas, an associate professor of neurology at Columbia, who conducted the studies. This type of diet may reduce inflammation, oxidative stress and other vascular risk factors such as high blood pressure—all of which may have a role in increasing risk for brain and heart diseases.

Mark Twain's Unlikely Board Game

Remembering British monarchs



You might know Mark Twain as the author of *Huckleberry Finn*, but the memory-challenged writer was also the inventor of "Mark Twain's Memory-Builder: A Game for Acquiring and Retaining All Sorts of Facts and Dates." The project started with Twain's daughters, Susy and Clara Clemens, who were unsuccessfully trying to learn the reigns of the English monarchs. Twain thought if he could help the girls see the dates, they would succeed. He went out to the driveway and measured out 817 feet—each foot represented a year—and planted a stake where the rule of each monarch started. Twain may not have known it, but his system was a variation on the ancient loci method used by rhetoric students in Greece and Rome, which organizes images in locations. Before long, Susy and Clara had nailed the assignment.

You can try it, too. Think of a place you know well, such as your house, and visualize locations in an order, like the front door, hallway, den. Assign each monarch to a location. To recall the reign of William I, think of a whale floating at your front door. The whale is the biggest fish, just as William was the most important king. For Henry II, think of a hen in the hallway; Richard the Lionhearted, a lion roaring in the living room; and so on.

The average native English-speaking American knows about 42,000 words by age 20 and around 48,000 words by age 60.

—GHENT UNIVERSITY STUDY

BERRIES

Research presented at the National Meeting of the American Chemical Society in Boston found that blueberries, strawberries and acai berries may help put the brakes on age-related cognitive decline by preserving the brain's natural "housekeeper" mechanism, which wanes with age. This mechanism helps get rid of toxic proteins associated with age-related memory loss.

6 Funny Things You Can Do to Remember

Unconventional tricks can make memories stick

Chew Gum

Your dentist might not like it, but if you need to remember a piece of information for about half an hour, pop in a piece of gum (sugarless is OK). Research has shown that people are better able to remember visual and audio memory tasks if they simultaneously chew gum. It keeps you more focused and improves concentration.

Draw an Alien

One old-fashioned way to remember a simple task—returning your library book, feeding your turtle—is to tie a red string around your finger. But if you use something more distinctive, you might have a better success rate. To prove the point, a research team from Harvard University and the University of Pennsylvania stationed assistants outside a coffee shop with two sets of materials to distribute. One set invited customers to show a plain flyer and attached coupon to get a dollar off their next purchase. The other made the same offer, with the difference that the flyer featured a stuffed alien doll. The alien delivered, according to the study, published in *Psychological Science*. Almost a quarter of customers who received the alien flyer remembered to use their coupons, while just 17% with the plain flyer did.

Smell the Rosemary

Roasting potatoes, meat or other edibles with rosemary is a sure way to kick the flavor up a notch, but it turns out that the smell of rosemary can also help you remember complex events and tasks. In some tests, people who sniffed essential oil from the herb had a 75% better recall than participants who didn't. Rosemary has also been shown to help alertness and arithmetic.

Stay Put

Have you ever walked through a doorway and couldn't remember why, or what you were looking for? You're not alone. It turns out that the simple act of passing from one room to another can make you go blank. The phenomenon is what University of Notre Dame psychology professor Gabriel Radvansky calls "event boundary." In a study published in the *Quarterly Journal of Experimental Psychology*, Radvansky had college students perform memory tasks while crossing a room and exiting a doorway. What he found in three different settings was that students forgot more after walking through a doorway versus moving the same distance across a room. His conclusion? The doorway or "event boundary" hurts your ability to retrieve thoughts made in a different room.

Use a Funny Font

The right typeface, or font, can make all the difference in a reading experience. You want the words to be legible and easy to read, whether it's in a book or on the internet. But if you want to remember what you're reading, you might want to switch it up, choosing the weirdest, most challenging font possible (but not bold or oversize fonts that make you think the words are easier). When something is unfamiliar and difficult to read, you are forced to concentrate on it more, allowing you to remember it more easily.

Eat Sour Patch Dolls and Other Odd Flavors

While learning a complex point for an exam, eat something with a distinctive taste, such as a sour candy. When you taste the same flavor again during the test, it should help you remember the concept and its finer details. Make sure the professor will let you take the candy into the test with you.

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People Inc.
Chief Business Officer, President Lifestyle Alysia Borsa

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Americans got hooked on memory games during the 15-year run of Concentration, *hosted by Hugh Downs, above, center.*

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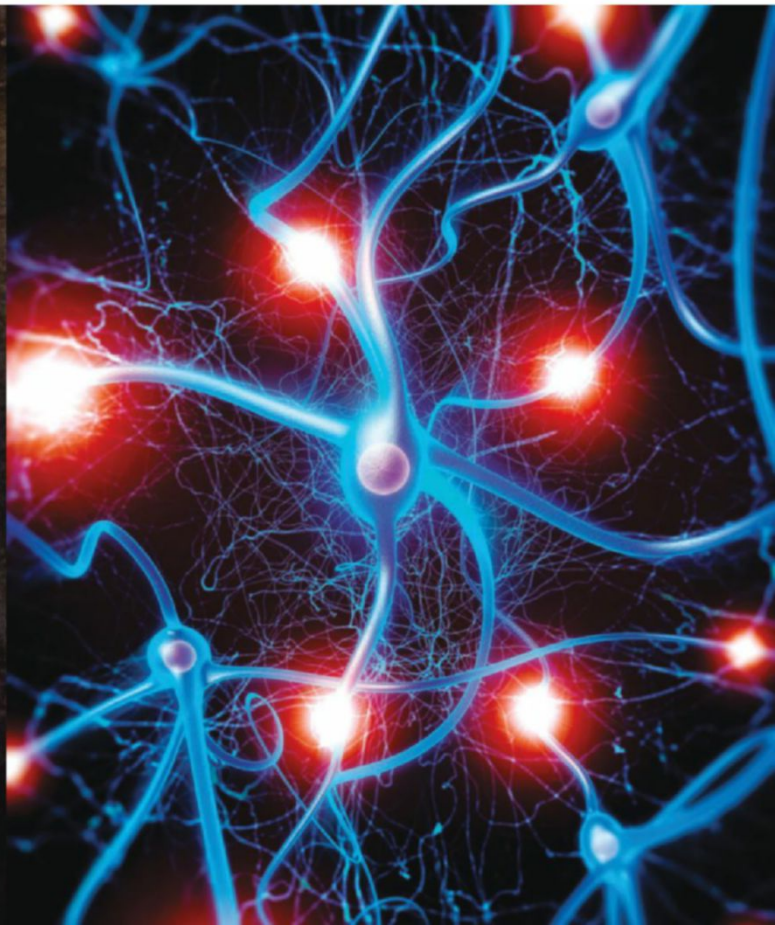
Total Recall

"God gave us memory so
that we might have roses in December."

–J.M. BARRIE

Why We Remember What We Remember

Memory is essential to our ability to survive, to learning, and to our sense of self. How do we do it?